Hydraulics & Pneumatics

OCTOBER 1960

NCIH

TIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS

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See page 34 for a report on current activities of the National Fluid Power Association and the Fluid Power Society

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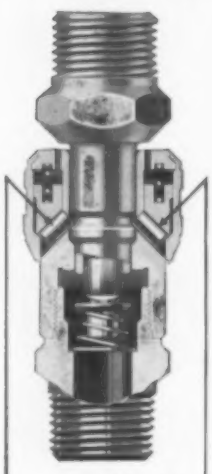

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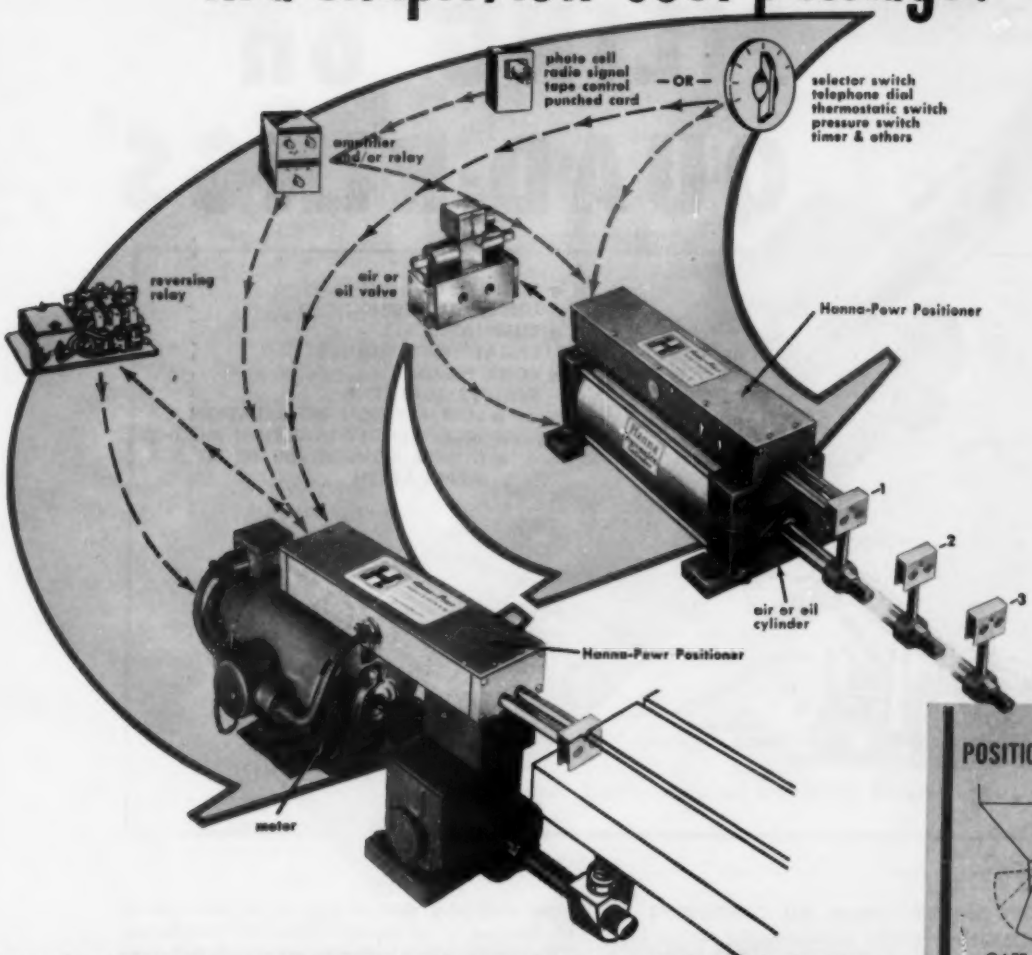

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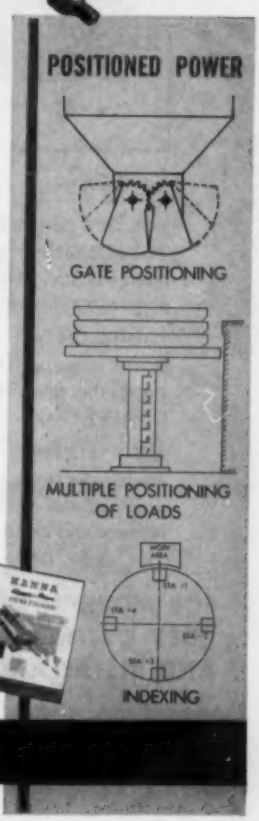

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VOLUME 13/NUMBER 10

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USEFUL LITERATURE

COMPREHENSIVE NO. 403 CATALOG SHOWS ANCHOR "O" RING FLANGED HEAD HYDRAULIC HOSE ASSEMBLIES, CLAMP TYPE COUPLINGS, HOSE and WELD FITTINGS

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Of special interest are the newest, up-to-date SAE dimensions for Industrial Hydraulic Flanged Tube, Pipe and Hose Connections—Four Bolt Split-Flange Type, and Port Dimensions for Bolted Flange connections. An Anchor *"first"*, the designs for these Anchor products have set the standard for the industry.

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Detailed comprehensive data and cross-section views with all dimensions for all Anchor "O" Ring Flanged Head Hydraulic Hose Assemblies, Clamp Type Couplings, Hose and Weld Fittings are included, together with valuable technical and engineering data to assist fluid power equipment users in ordering these Anchor products . . . *"first"* for years in original equipment.

Copies of the new Anchor Catalog No. 403, a practical working tool for specifying and ordering Anchor top-quality, performance-proven "O" Ring Flanged Head Hydraulic Hose Assemblies, Split-Flanges, Clamp Type Couplings, Hose and Weld Fittings will be sent, on letterhead request, by writing Anchor Coupling Co., Inc. 366 North Fourth St., Libertyville, Ill.

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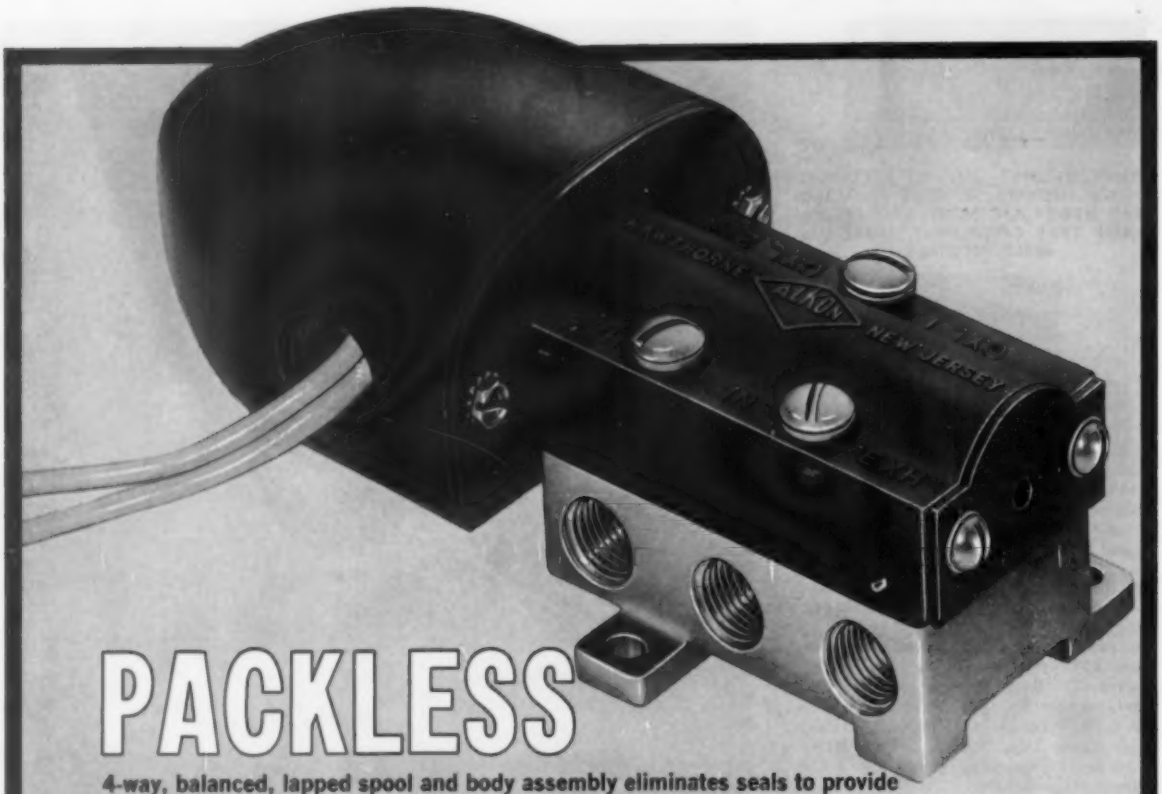

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FLUID POWER LINES

about hydraulics & pneumatics

JUDGE FOR YOURSELF . . . Like every October issue for the past eight years, this one is outstanding for presenting the three top entries in the annual HYDRAULICS & PNEUMATICS Prize Paper Contest. This year the winning articles represent outstanding work and original thinking in servovalves, pneumatic systems, and aircraft surface control.

Continuing the high quality, of this year's top awards, the four winners of $100 prizes treated both hydraulic and pneumatic design in applications and development of basic technology. A circuit design method in the British paper by Arthur Salek presents a fascinating puzzle-solver to set up almost any sequencing circuit using the minimum number of components. Dieter Tannenberg's entry on shock presents equations to determine magnitude and velocity of shock waves. Problems of hydraulic mobile equipment and missile ground handling are similar, as shown by Fred Weir's paper on equipment for lifting and handling rocket engines. Frank Acton, winner of last year's first prize, scores again by describing development of a 3-position cylinder for a machine tool.

These papers and those receiving honorable mention will be published in coming issues.

SERVOS FOR ALL THEY'RE WORTH . . . Lots of attention is being focused these days on servovalves, and it's notable that this year's $500 winner, as well as several honorable mention entries, deal with these new and developing components. The exhaustive treatment, *Principles of Servovalves,* that Werner Holzbock has written analyzes basic characteristics of flapper-nozzle, jet-nozzle, and spool valves. Understanding what a valve can do is especially important in designing servo systems where each component's performance affects the others'.

GOODBYE TO TRIAL AND ERROR . . . Flow coefficients are common in process and fluid handling system design, but their value is just being recognized for pneumatics. Basically the coefficient is a constant which relates fluid flow through a component to pressure drop across it. Gil Riske's second prize winner, *Using Flow Coefficients to Design Pneumatic Systems* shows the way to analytical system design that's not expensively oversized, yet avoids excessive pressure drops.

CRUSADER'S HYDRAULICS . . . Since it first began serving with the Navy in 1957, Chance-Vought's F8U jet fighter has been a first line weapon. Hydraulic design of the latest version is discussed in the $200 winning, *Designing Dampers to Stabilize a Jet Fighter* by J. R. Crissey. You can follow the design philosophy in the development of valve dampers, filtering, plumbing, cylinders, and protection against corrosion.

NCIHFPSSYT . . . No, you have not just caught H & P in a typographical error. That impressive abbreviation can be broken down into National Conference on Industrial Hydraulics, Fluid Power Society, *See You There.* Program and abstracts of the NCIH start on page 90. The FPS, a new organization, holds its first annual meeting the day before the conference. See page 42 for more details.

Now manifold any number of ROSS 4-way PACER valves with new

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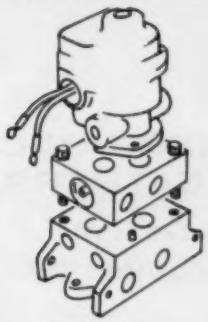
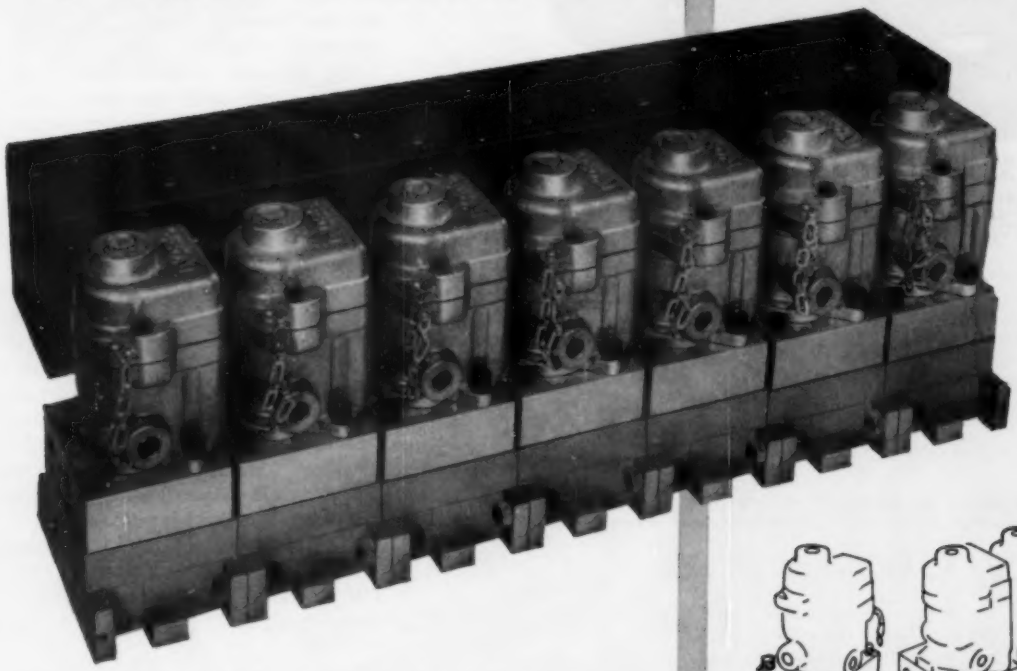
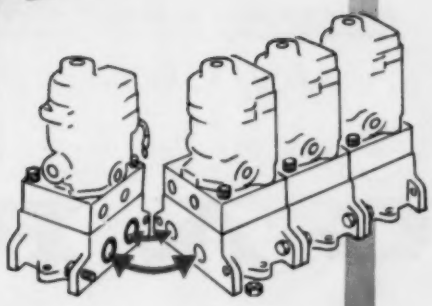


Attach PACER 4-way valve to manifold box with just two cap screws. All air connections are automatically made.





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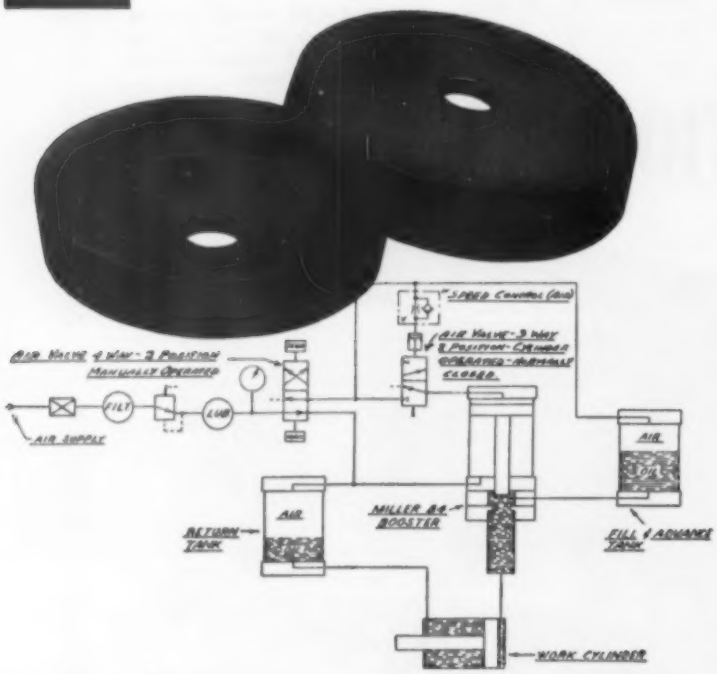

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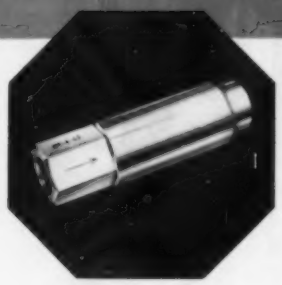

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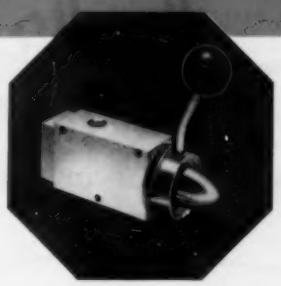

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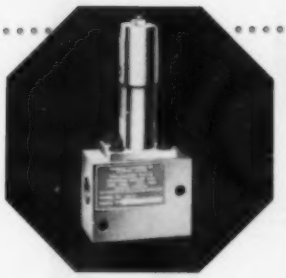

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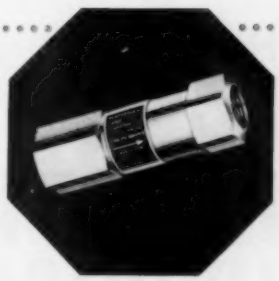

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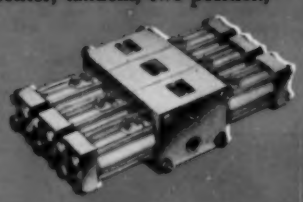

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FOR EASE OF FINISHING HYDRAULIC CYLINDERS SPECIFY

B&W *Job-Matched seamless mechanical tubing*

B&W's comprehensive quality control procedure provides . . .

• good surface finish • dimensional accuracy
• controlled uniform mechanical properties

Quality is only one of the many reasons why it pays to specify B&W Seamless Mechanical Tubing. And remember, matching tubes to jobs assures low optimum cost as well as ease of finishing. For more information call your local B&W District Sales Office or write for Bulletin TB-418. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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TUBULAR PRODUCTS DIVISION

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Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

Circle 19 on Time-Saver Card

Circle 118 →

... Fluid Power news

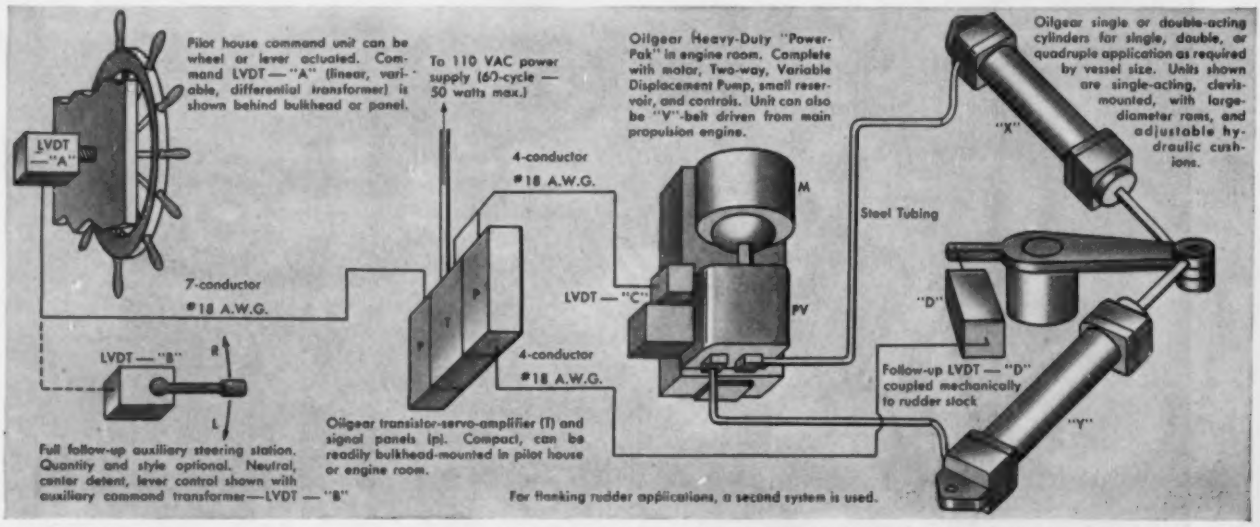
REPORT No. 11,702 NEW MARINE STEERING CONCEPT

From Oilgear Application-Engineering Files

HOW OILGEAR APPLICATION-ENGINEERING AIDED CREATION OF MODERN MARINE STEERING GEAR

CUSTOMER: *A long-established Marine Engineering Company (name on request)*

DATA: This company's technical staff concluded that marine steering gear could be modernized instead of merely being made larger and heavier. A design program to incorporate new electric and hydraulic developments had the following basic objectives. 1: Extreme flexibility for normal application on all vessels requiring power steering. 2: New economy in system weight, size, and installed cost. 3: Simplicity, accuracy, reliability. 4: Full follow-up pilot house and auxiliary station control of rudder movement, speed, position. 5: Eliminate make-and-break, or sliding electrical contacts, relays, vacuum tubes, solenoid valves, heavy shafting, gears, racks, and linkage in the control system. Smooth, positively indexed, rate responsive, stepless rudder movement control that is noise, shock, vibration, and pulsation-free. 7: Compatible with gyro-compass, automatic steering.


Pilot house command unit can be wheel or lever actuated. Command LVDT — "A" (linear, variable, differential transformer) is shown behind bulkhead or panel.
LVDT — "A"
To 110 VAC power supply (60-cycle — 50 watts max.)
Oilgear Heavy-Duty "Power-Pak" in engine room. Complete with motor, Two-way, Variable Displacement Pump, small reservoir, and controls. Unit can also be "V"-belt driven from main propulsion engine.
Oilgear single or double-acting cylinders for single, double, or quadruple application as required by vessel size. Units shown are single-acting, clevis-mounted, with large-diameter rams, and adjustable hydraulic cushions.
4-conductor #18 A.W.G.
M
PV
"X"
Steel Tubing
7-conductor #18 A.W.G.
LVDT — "C"
"D"
LVDT — "B"
R
L
4-conductor #18 A.W.G.
Follow-up LVDT — "D" coupled mechanically to rudder stock
"Y"
Oilgear transistor-servo-amplifier (T) and signal panels (p). Compact, can be readily bulkhead-mounted in pilot house or engine room.
Full follow-up auxiliary steering station. Quantity and style optional. Neutral, center detent, lever control shown with auxiliary command transformer—LVDT — "B"
For flanking rudder applications, a second system is used.

SOLUTION: Above schematic symbolizes an Oilgear Fluid Powered, electrically controlled, marine steering system utilizing the newest electric-hydraulic developments. *Actual installations using this new Oilgear "electro-feedback-hydraulic-servo-control system" have exceeded ALL of the customer's original engineering objectives...* proof of Oilgear's cooperation and teamwork to help solve design engineer's problems. Oilgear Heavy-Duty "Power-Paks" are complete, ready-to-install power units in sizes and types to meet every marine need. No auxiliary valves, pumps, controls, reservoirs, or "plumbing" are required. Oilgear "Custom-Quality" single and double-acting cylinders can furnish the "muscle" to control any type vessel. Oilgear ServoControl Division's rugged, compact transistor-servo-amplifier and control system is further proof of Oilgear progressive, pioneering, engineering service. Connections between the amplifier and signal generators can be made by any competent electrician.

In every industry, manufacturers and users recognize and trust the name "Oilgear" for dependable, lowest-cost-per-year operation.

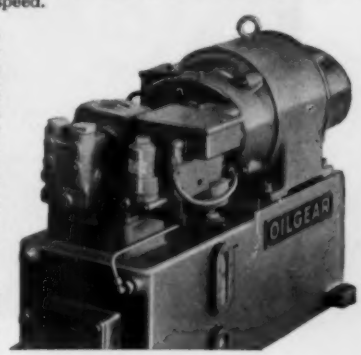
For similar practical solutions to YOUR linear or rotary Controlled-Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to...

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1564 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

OPERATION: LVDT units (A, B, C, D) are actually coils with a core or slug moved axially in the coil airgap. When core is at central position there is a "null" signal. Maximum signal is emitted at maximum limits of travel — either "in" or "out." Movement of wheel or steering lever displaces core of command LVDT (A or B), producing a signal that is compared in transistor amplifier (T) with the signal from rudder stock coupled LVDT (D). Resulting difference between these two signals is called the "error" signal — built up to usable current strength by amplifier (T). Amplified signal is applied to an AC torque motor on Oilgear Two-way, Variable Displacement Pump (PV), imparting movement in amount and direction as ordered to a hydraulic servo valve — stroking pump (PV) to supply ordered direction and volume to rudder actuating cylinders (X, Y). As rudder moves, coupled LVDT (D) is displaced to reduce error signal to zero — at which point the cycle is complete. During this cycle, pump LVDT (C) has also been sending its signal to the amplifier for comparison, insuring that pump output is always under error signal control. Rapid motion of the command wheel or lever generates a large error signal, resulting in full rudder speed. Similarly, a slow command movement results in a slow rudder speed.

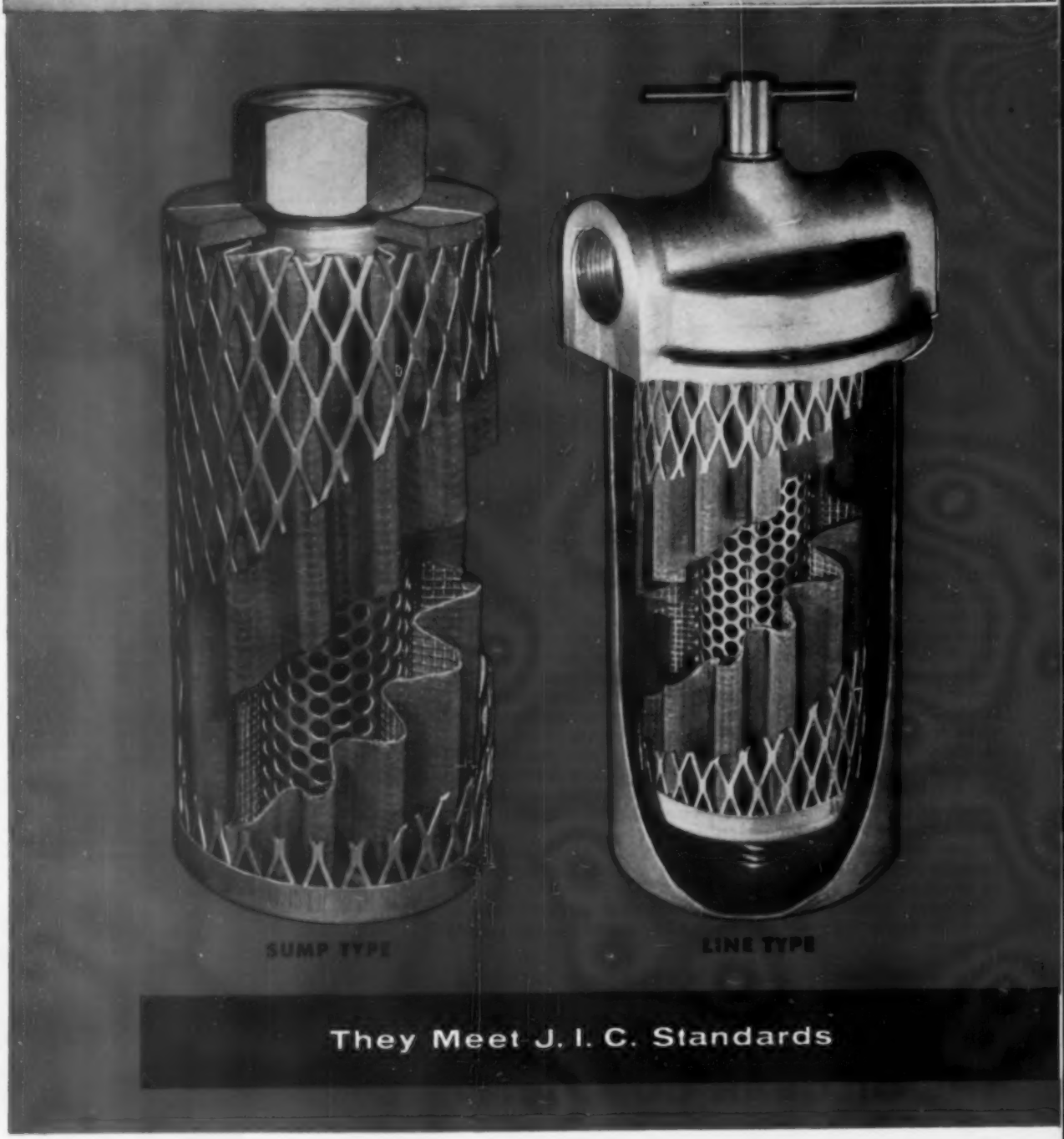


RIGHT: Oilgear Size 3, Heavy-Duty "Power-Pak" with Two-way, Variable Displacement Pump, motor, reservoir and controls . . . "as shipped," ready for installation with an "electro-feedback" system described above. This unit is now in use on a new 144' x 55' x 5' draft ferry boat of 483-ton displacement.

Similar Oilgear Systems are being used on other vessels for both steering and flanking operations.

FILTER *Quality* cannot be

SINCE 1943



They Meet J. I. C. Standards

compromised by FILTER Price!

THE ANSWER TO FILTER Quality IS

MARVEL

SYNCLINAL FILTERS

Over 900 O.E.M.'s can't be wrong!

16 years ago, Marvel Engineering Co. produced the first filter designed to maintain the cleanliness of oils, imperative in hydraulics and other low pressure circulating systems. Acceptance of Marvel Synclinal Filters to meet these rigid requirements sparked the surge to our leadership in this field, the status we presently maintain. This fact is attested by well over 900 Original Equipment Manufacturers, who are installing Marvel Synclinal Filters as standard equipment.

For further information—
write, wire or phone:

Check these EXCLUSIVE Marvel Features:

- **BALANCED SYNCLINAL DESIGN.** The all-important balance between *ACTIVE* filtering area and storage capacity for filtered out particles in Marvel Synclinal Filters provide longer periods of efficient filtration and dependable protection on hydraulic and other low-pressure circulating systems.
- **CONSTRUCTION.** Marvel Filters are of sturdy construction with all parts interchangeable. Should any part become damaged by accident or mishandling, you need only to replace the damaged part rather than purchasing a complete new filter. Your first cost may very well be your only cost.
- **VERSATILITY.** Marvel Synclinal Filters are available for Sump or Line installations. Eight individual capacity sizes from 5 to 100 G.P.M. You can get a filter for the particular fluid you are using—regular petroleum base hydraulic oils, all types of Fire-resistant hydraulic fluids, coolants, lubricants or water.
- **DEGREE OF FILTRATION.** Filtering media in Marvel Synclinal Filters is Monel Wire Cloth available in mesh sizes of 30-40-50-60-80-100-150 and 200 to meet your degree of filtration requirements. Before fabricated into Marvel Synclinal Filters, all wire cloth is subjected to rigid inspection at our plant. No factory rejected cloth or remnants are ever used.
- **EASY TO CLEAN.** Marvel Filters are easily disassembled, thoroughly cleaned and re-assembled in a matter of minutes—resulting in the equivalent of a brand new filter, ready for another long period of efficient service.
- **IMMEDIATE DELIVERY.** Marvel not only delivers a top grade filter in both quality and performance, but delivers IMMEDIATELY—a phone call can get your shipment on its way TODAY!

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IT'S WHAT HAPPENS ON

your job

THAT COUNTS! BHEW 'on-the-job' performance saves you money! Costly breakdowns and expensive maintenance do not make for efficiency. With BHEW products you are assured of dependable performance, long life and easy maintenance. These are the custom features that characterize all BHEW products.

BHEW's Hollow Rod Cylinders are two-piece tubular rods that allow oil to flow through the rod in two separate channels to operate double-acting cylinders. You benefit from this application because the cylinder barrel is plain without port connections and the rod is anchored in a stationary position. The barrel is the reciprocating member.

DISCUSS YOUR DESIGN AND APPLICATION PROBLEMS WITH US!

WRITE TODAY for free Hydraulic Cylinder Engineering Reference data. 78 dimensional basic designs for general purpose and special double- and single-acting cylinders. SAVE TIME!

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BENTON HARBOR ENGINEERING WORKS, INC.

622 Langley Avenue • St. Joseph, Michigan

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LETTERS to the editor

Address your letters to: Editor, HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Coiled tubing

TO THE EDITOR:

I have read your special report "Plastic Lines" in the April issue of APPLIED HYDRAULICS & PNEUMATICS.

I am extremely interested in obtaining information on coiled nylon tubing. Could you refer me to the source of this tubing, also fittings for such a line?

The size I am interested in is for ¼ inch port.

WILLIAM C. CHAMBERLAIN
Design Engineer
J. W. Greer Company
Wilmington, Mass.

Information has been sent.

Hydrostatic drives

TO THE EDITOR:

Our engineering group has been working on various projects, seval of these are in the hydraulic motor and pump category.

Recently considerable space has been devoted to the use of hydrostatic drive mechanisms. Would you be in a position to tell us where information has been printed on this subject. We are aware of the items covered in the Industrial Arts Index but would like any further reference material not covered by these listings.

Would you please send us reprints and any information you can supply us on this subject.

E. B. NETTLES
Supervisor
Market Analysis Section
American Bosch Arma Corp.
Springfirld, Mass.

We have printed a number of articles telling design details of equipment using a combination of hydraulic pump and motor. We are enclosing our annual indexes

Continued on page 18

APPROACH YOUR DESIGN PROBLEMS from ANY ANGLE

with Eastman Low Cost Industrial SWIVEL CONNECTORS

Licensed Under Pat. No. 2481404

Yes, you can approach your design problems from *any angle* — from any of the six sides of EASTMAN'S *newly improved* Industrial Swivel Connector.

Never before has any fitting equaled its adaptability and versatility. You can stack them, line them up parallel, horizontal or vertical . . . in a "T," if need be.

Not only can you simplify design problems, but you can improve the maneuverability of your equipment . . . raise or lower buckets or blades. You are able to change the angle of the cut right or left, up or down . . . *on the go.*

EASTMAN Industrial Swivel Connectors eliminate costly hose failures due to excessive flexing; permit use of shorter lengths of hose and help eliminate complicated assemblies.

Improved interior design provides "balanced" fluid flow *at any angle.* Chrome hardened, cadmium plated interior surfaces, burnished to a mirror finish, improve performance. SIX sealing rings: 2 leather dust seals, 2 synthetic back-up washers and 2 quad rings of oil-resistant rubber (−40° to +200°) assure dust-free field service and less down time.

If you have been "designing around" Swivel Connectors because of high cost . . . rest assured that EASTMAN'S Industrial Swivel Connectors will not only reduce your original cost but lower your customers' operating costs as well.

Exhaustive Tests at 3000 p.s.i. through 1½ million cycles, with the connector covered with abrasives and dirt, simulating field conditions, proved EASTMAN'S Industrial Swivel Connector satisfactory in every respect and did not cause failure of any kind.

Cut corners while you cut costs with these economical Eastman Industrial Swivel Connectors.

Eliminate installations of lengthy, complicated hose assemblies, junction boxes and multiple adapters.

Improve uniform power delivery and operating efficiency, reduce costly field replacement and down time.

- **LOW TORQUE**—Freedom from friction, even under high pressure.
- **WIDE RANGE**—Operating pressures up to 3000 p.s.i. trouble-free operation through wide temperature range (−40° to +200°).
- **ROTATION**—Full 360° for all manifolds.
- **SIZES**—Steel, plated for corrosion protection—½", ¾", 1", 1¼". Other sizes available on request.

Write for Technical Bulletin No. 59 on Eastman's new improved swivel connector.

Eastman MANUFACTURING COMPANY
DEPT. AH-10 MANITOWOC, WIS

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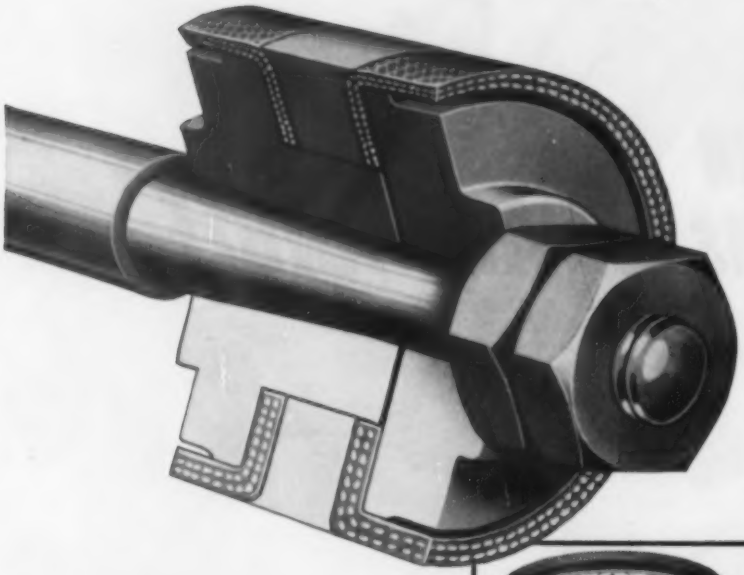


WHY PUMCUPS MAKE A DIFFERENCE

Darcova Pumcup

Darcova 45° Bevel Type Pumcup

- **in reciprocating pumps**
- **in air and hydraulic cylinders**

With Darcova Pumcups in your cylinders, there's less fluid slippage. High volumetric efficiency is maintained and Pumcups outlast other packings at least 3 to 1! There's less down-time! Lower power cost! Smoother operation! Less maintenance and replacement!

Longer life is the result of truly advanced cup engineering, including 100% nylon composition, plus a choice of types, textures and precision sizes to exactly match fluid, cylinder, pressure and temperature conditions.

These same factors contribute to prolonged high efficiency by permitting full advantage of the "cup principle". Thus fluid pressure always keeps Pumcups snug against cylinder wall, despite eventual wear, while the total frictional load is minimized.

Send for Bulletin 5503. It will give you *all* the facts.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP
TRADE MARK
PUMCUPS

Circle **43** on Time-Saver Card

LETTERS

for 1958 *and* 1959. *You'll find these articles listed under "Fluid Motors". In December* 1956 *we devoted an entire issue to hydrostatic drives on mobile equipment.*

If you can give us more specific information on what type of equipment you are considering or what type of drive you have in mind, we believe we can be of more help in selecting the articles that would be valuable to you.

Automatic tension control

TO THE EDITOR:

In your March issue of HYDRAULICS & PNEUMATICS we noted an item on automatic tension control produced by Web Control Corporation. We would appreciate some additional information on this subject and would also appreciate your letting us have the address.

H. J. ANDERSON
H. H. Anderson & Co.
Toronto, Canada

This tension control is manufactured by Web Control Corp., 318 Briarcliff Rd., West Englewood, N. J. We suggest you contact the company directly for more information.

Fluid nomenclature

TO THE EDITOR

The article "High Temperature Fluids for the B-58", March 1960, issue, contains, I believe, some misinformation which should be clarified:

1. The current designation of MIL-O-5606 is MIL-H-5606A.
2. The WADC fluid referred to as MIL-O-8200 is MLO8200. MLO designates materials laboratory oil.
3. The 85% silicate ester and 15% diester oil is a silicate rather than silicone oil. The correct designation for this fluid is MLO 85/15.

C. W. GALLOWAY
Dept. A-852
Douglas Aircraft Company
Santa Monica, Calif.

▼▼▼

interchangeable with all standard JIC cylinders

With the introduction of the ALL NEW T-J Squair Head, Tomkins-Johnson now offers industry the most complete design range of air and hydraulic cylinders. Presently available in bore diameters from 1½ to 8 inches, the T-J Squair Head is an interchangeable cylinder which produces maximum force and efficiency, with minimum pressures... and is also adaptable to the use of low pressure oil as the working medium. Write to The Tomkins-Johnson Co., Jackson, Michigan, for Bulletin #SQ 10-58 and complete details.

CHECK THESE 10 POINTS OF T-J SUPERIORITY

1 One Piece Piston

2 Hard Chrome Cylinder Bore and Piston Rods

3 High Tensile Steel Tie-Rods

4 Cushion Adjusting Screw, Externally Adjustable

5 New Super-Cushion for air, or Self-Aligning Master Seal for Oil (T-J Patents)

6 Solid Steel Heads and Mounting Plates Standard all Models

7 Port Design Allows Minimum Pressure Drop on Inlet or Outlet

8 "V" Type, Self-Adjusting Rod Packing

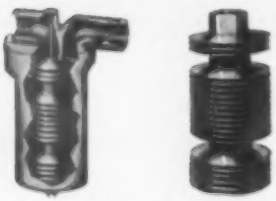
9 Piloted Packing Gland—Absolute Alignment

10 Piston Rod, Extra Strong—Polished and Chrome Plated for Efficiency and Protection

T-J TOMKINS-JOHNSON

Here's a magnetic strainer with a fatal charm

Ripley magnetic Sump and Line Strainers combine magnets and screens for a positive 2-way filter trap!



Line Strainer Sump Strainer

The irresistible magnetic force of Ripley Sump and Line Strainers *attracts*—and *traps* iron and metallic particles! Non-ferrous matter is stopped by the removable filter disc screens, giving efficient, effective protection for all types of hydraulic systems. Both Sump and Line models can also be custom made for all unusual applications. Write today for complete information!

RIPLEY

SCREEN AND STRAINER CO.

Filter Division

32749 Northwestern Hwy., Farmington, Mich.

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FLUID POWER FORUM

Each month HYDRAULICS & PNEUMATICS surveys readers for their experiences and opinions in fluid power design.

• *What is your preference for cylinder packing (dynamic) for pistons and rods? O-rings, U-rings, V-rings, cups, flanges, piston rings, etc? Why? What problems have you had with packing? Material, size, shape, supply, leakage, etc?*

For critical jobs I have had best results with metallic packing cartridge units. When you pay attention to good finish, O-rings are OK. They are not so good running on cast iron.

J. DECKER
Cincinnati Milling Machine Co.
Cincinnati, Ohio

Your question could most certainly cause speculation and argument. Having spent some years in the packing business, I seriously doubt that any thinking person could give one preference that would fit for all times and conditions.

My personal preference would be V-rings. This packing gives long trouble-free service, a good economy range, and a minimum of downtime. In addition, V-rings are available today in such a variety of compounds and methods of manufacture that they may be applied with many of the most exotic fluids.

Yet there are disadvantages too. They are sometimes difficult to install. Also the user may be displeased by the first cost both of the packing and the machining required.

Actually, the choice of packing depends on many, many things. Each packing application is an individual one. It can only be solved when all information, both technical and economic, is taken into consideration.

THEODORE G. THOMAS
T. G. Thomas Co.
San Antonio, Texas

Cylinder packing at our company is U-ring or cup for the piston, and V-ring for the rod end. Many of our applications require no leakage past the piston. Experience indicates that in a circuit with a closed-center valve and double-acting cylinder, piston rings will leak, and cause the piston to drift. We do not want this. Installing U-rings or cups on the piston has eliminated drifting. Also break-away friction isn't as great on U-rings or cups as on piston rings.

The V-rings on the rod end of the cylinder can be re-tightened when there is leakage around the rod. This usually stops the leakage until a scheduled machine downtime.

A problem here on the West Coast is long delivery time which packing manufacturers don't seem to be aware of. If deliveries were faster, packing companies would have a larger business. There are West Coast manufacturers that are very good. But the larger the selection of packing, the better the packings, both in supply and quality.

MELVIN COCHRAN
Designer
Hunter Engineering Co.
Riverside, Calif.

• *JIC Standards now approve welded tubing. How will this affect your designs for cylinders and lines?*

Because most of our work is concerned with unusual applications of hydraulic equipment, we use standards as a guide, but not a law. We are in favor of standards. Without them usefulness of production equipment would be considerably reduced and the consequent advantages of cost reduction lost. However, it is very easy

Continued on page 22

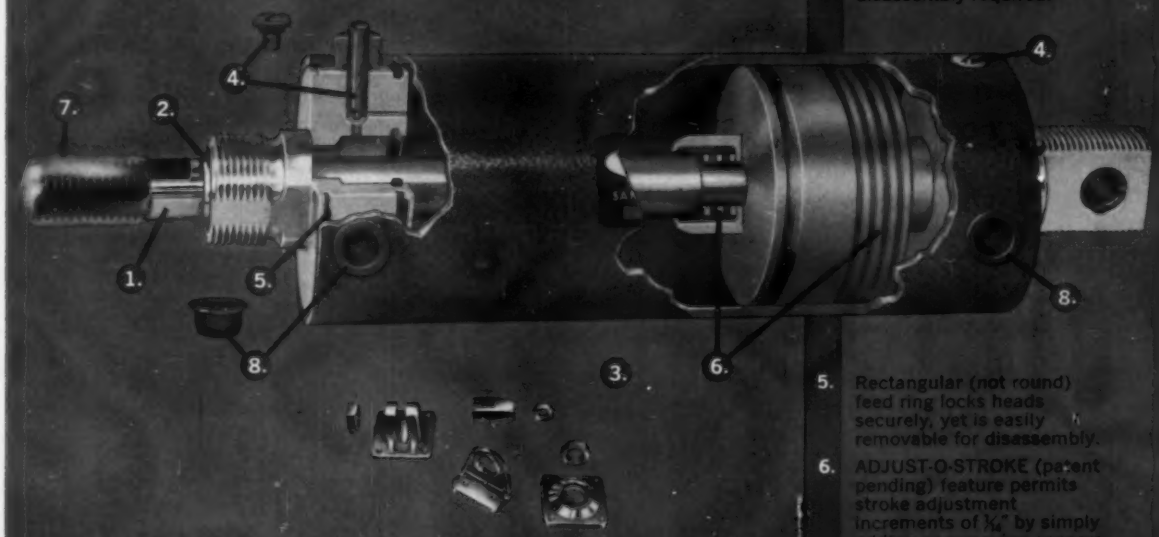
another **NEW PRODUCT** *from . . .*

Modernair
® Trademark

check these important features . . .

SERIES **R** ECONOMAIR CYLINDER

1. Hard chrome-plated steel piston rod with rod flats.*
2. Metallic rod wiper, with automatic wear compensation.
3. Interchangeable mountings.
4. Cushions "now or later"—to add cushions, simply remove plug and insert cushion needle valve; no cylinder disassembly required.*



5. Rectangular (not round) feed ring locks heads securely, yet is easily removable for disassembly.
6. ADJUST-O-STROKE (patent pending) feature permits stroke adjustment increments of ¼" by simply adding or removing spacers; total adjustment is ½".*
7. Strippable plastic (government approved) protects all threads during shipment or storage.
8. Plastic plugs protect ports until used.

*Not available on 1½" bore sizes which have stainless steel rods, fixed cushions.

New Series R Economair cylinders are available for immediate delivery in 1½", 1¾", 2", 3" and 4" bore sizes. See your phone book yellow pages for your nearest Modernair dealer, or write us for catalog, price list.

Please address Dept. 65

Modernair
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Phone: LOckhaven 2-6465

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Cleveland 34, Ohio
Phone: SHadyside 8-6393

MEMBER NATIONAL FLUID POWER ASSOCIATION

TRANSFER MACHINE BUILT BY BUHR MACHINE TOOL CO., ANN ARBOR, MICHIGAN

Automated GIANTS like this

REQUIRE STRONG HYDRAULIC *HEARTS* EVERY MINUTE OF THEIR WORKING LIFE

24 RACINE PUMPS
operate this 58 station 500-ton transfer machine

The precisioned flow control of RACINE PUMPS assures the split-second timing and efficiency required to operate this complex Buhr Transfer Machine . . . custom-built for the completely automatic machining of 120 auto-cylinder heads hourly for a leading automotive manufacturer. Compact RACINE VALVES control feeds and reverse movements on all 323 operations performed by the machine. RACINE 4-WAY SOLENOIDS help one man operate this mechanical giant. Buhr has used RACINE PUMPS and Reservoir Units on custom-built machines for the automotive industry for over 10 years.

RACINE

Racine Hydraulics & Machinery, Inc.
RACINE, WISCONSIN
HYDRAULICS DIVISION

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FORUM

for "standards" to become a barrier instead of a path. This happens most often during the introduction of new techniques, processes, or hardware. More effort should be made to separate "standards" which influence details such as to assure interchangeability, etc.; and "standards" which in effect constitute handbook design. They not only relieve the designer of any responsibility, but preclude the use of any ingenuity.

C. D. CHRISTOPHERSON
Project Manager
FluiDyne Engineering Corp.
Minneapolis, Minn.

I do not think that our design will be changed from our present method of fabricating tubing. I do believe that the welding of tubing is a great step forward for the industry. Aside from the high cost of fabrication I believe that it is probably the most reliable and safest method of plumbing that has yet been devised.

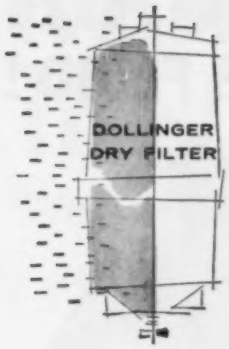
J. BILLER
Design Engineer
Link Aviation, Inc.
Binghamton, N. Y.

● *What features do you want in the ideal fluid reservoir? Can you get the features you need? What complaints do you have about present reservoirs?*

Basically, a reservoir should contain sufficient oil from which the system may draw as needed. The rule of thumb I use to determine the capacity of a hydraulic reservoir is 3 times the rated pump delivery in gpm. In addition, be sure to allow sufficient space above the oil for air escape.

In the reservoir, oil undergoes its greatest danger: contamination. To reduce the danger at least one vertical baffle should be in the reservoir to separate exhaust oil from intake oil. In my opinion the following feature should be considered in reservoir design: Two

Continued on page 26



SPECIALISTS
FOR 39 YEARS

RESIST SYNTHETIC OIL TO 300°F

Filters for sump pumps and hydraulically operated equipment

DOLLINGER STAYNEW SUMP FILTERS are designed with new molded end seals of special plastic impervious to all synthetic oils, mild acids, coolants and water to 300°F. Filter medium is a mesh cloth available in either 60 or 100 screen depending on efficiency required and fluid viscosity. Exclusive radial fin design offers the greatest active filtering area in any given space. Staynew Sump Filters can be installed single or in multiple units . . . come in eight standard sizes with capacities from 5 to 100 GPM. Leading manufacturers specify Staynew Sump Filters for positive protection against dirt, sludge, rust and abrasive particles that cause expensive pump failures. Ask your local Dollinger representative for more details. Or, write for Bulletin 330-H. Dollinger Corporation, 65 Centre Park, Rochester 3, N. Y.

STAYNEW FILTERS

DOLLINGER

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS • HIGH PRESSURE FILTERS AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

PARKER PIONEERS AGAIN

LEAKPROOF PORTS WHATEVER THE FLUID!

NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW

PARKER NOW OFFERS A METAL SEAL TO FIT THE S. A. E. STRAIGHT THREAD BOSS

Parker, whose straight thread fittings and straight thread ports have been accepted by S.A.E. (and now by J.I.C.) as industry standards for hydraulic devices, has now developed a **stainless steel** seal for use where the convential, synthetic rubber "O" ring is not acceptable.

Their new all-metal straight thread fitting features this resilient stainless seal, **which seats within the confines of the S.A.E. straight thread boss configuration.** The new seal cannot be removed from the fitting and, therefore, cannot be lost. It can be used again and again without damage to the boss or to itself. Because it is 304 stainless, it works equally well with every known hydraulic fluid, petroleum-base or fire-resistant.

Parker offers steel and stainless steel straight-thread fittings with stainless seals in both their "Triple-lok®" 37° flare design (illustrated) and their "Ferulok®" flareless, "bite-type" design. Also available from Parker are tools with which to cut the mating S.A.E. boss.

Hydraulic designers who have hesitated to standardize on the leakproof S.A.E. straight thread boss on applications where they could not be sure what hydraulic fluid would be used are invited to write for complete engineering test data on this new development.

PARKER HANNIFIN CORPORATION

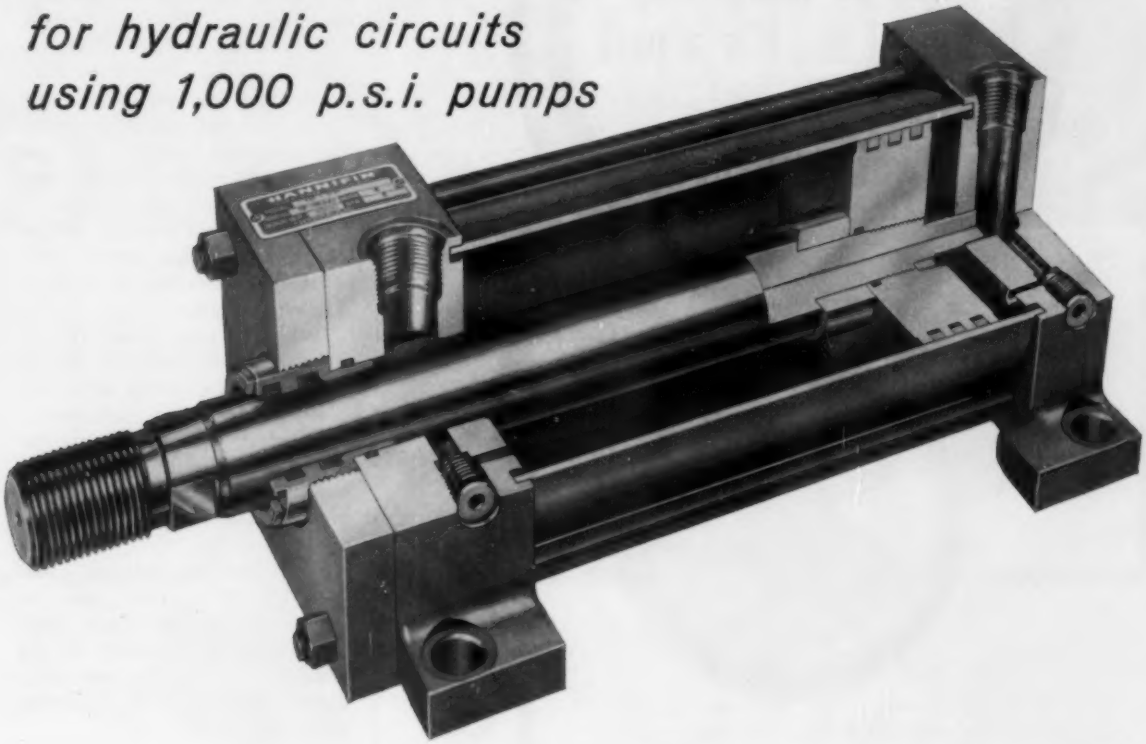
Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

5100-P3E

Circle **123** on Time-Saver Card

NEW FROM HANNIFIN
THE THOUSAND POUND LINE!

for hydraulic circuits
using 1,000 p.s.i. pumps



- *A true hydraulic cylinder — not a modified air cylinder*
- *Offered in nine bore sizes — 1" through 8"*
- *Every model withstands at least 1,000 p.s.i. in every bore size*
- *Built to save you money — yet not "built to a price"*

Now, for the first time in hydraulic cylinder manufacture, Hannifin offers a top quality cylinder tailored to the medium-high-pressure hydraulic circuits you operate off 1,000 p.s.i. pumps.

Series "L," the "Thousand Pound Line," is NOT a modified heavy duty air cylinder. It is built for the job . . . with steel heads and steel barrel for full compliance with J.I.C. hydraulic recommendations. Other extra-quality features include an induction hardened and hard chrome plated rod, nodular iron piston with cast-iron piston rings — leakproof "Lipseals®," optional — longer cushions on cushioned models, and the Hannifin-developed bronze cartridge gland with both "Lipseal®" and "Wiperseal" to keep the rod drip-free. S.A.E. straight thread "O" ring ports as recommended by J.I.C. are optional at no extra cost just as they are in the Hannifin heavy duty Series "H" hydraulic cylinder.

Parker-Hannifin field engineering service can help you meet your needs precisely, help you select the proper Hannifin cylinder for any service, air or hydraulic. Call your nearest Parker-Hannifin sales office or write direct for our new bulletin giving all dimensions of Hannifin Series "L" cylinders.

HANNIFIN COMPANY
A DIVISION
545 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3077-PH

The quality of Precision "O" Rings protects the quality and performance standards you set for your product. They add to the reliability of your product in use . . . help preserve your reputation as a manufacturer of a reliable product.

Precision "O" Rings give you assurance, for their quality is maintained by over 100 inspections and quality control tests. They meet all military and commercial specifications. If it's a Precision "O" Ring, it's Precision-made!

There is no substitute for reliability. Write, wire or phone for data sheets on "O" rings or for the help of a Precision Sales Engineer today.

Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

Dept. 1, Oakridge Drive, Dayton 7, Ohio **Canadian plant at: Ste. Thérèse de Blainville, Québec**

Circle **170** on Time-Saver Card

FORUM

baffles placed across the width of the unit about 2/3 normal-oil-level high, to divide the tank into three sections. The first section would receive system discharge and allow deaeration of the fluid as well as contaminant settling. The second section would also be a contaminant settling area, but being without direct turbulence, would allow far better settling. The third section would be the intake area containing intake filters capable of micronic as well as magnetic filtration.

This baffling arrangement places the intake and discharge lines at the farthest ends of the unit. This allows greater settling and cooling time before the oil re-enters the system. This baffling is of most benefit to systems subjected to great atmospheric particle contamination.

Items such as clean-out openings, air filters, filler caps, oil level indicators, and drain plugs would remain standard. If the drain plug, however, were in a dished tank bottom, draining would be easier.

JOHN CHRONIS
Sales Engineer
Haskel Engineering and Supply Co.
Daly City, Calif.

Reservoirs should aid in removing all dirt and foam and provide cooling area. We have had to provide magnets in our reservoirs to remove steel particles. This often means redesigning the oil flow pattern so all oil will pass over the magnet. Most present reservoirs could be designed at the factory with removable magnets.

Present reservoirs do not keep dirt out. Paper dust particularly will seep in around the suction and return lines. Better sealing for long term use should be designed in.

J. CALDICOTT
Supervisor
Mac Millan Bloedel
Powell River, British Columbia
Canada

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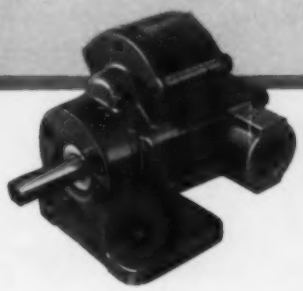
for precision hydraulic power pumps

CONSTANT DISPLACEMENT GEAR TYPES WITH ELEVEN DIFFERENT GALLONAGE OUTPUTS... DESIGNED FOR 1000 PSI SERVICE WITH RATED CAPACITIES OF FROM 1.4 TO 47.5 GPM AT 1800 RPM



Precision-built for long, trouble-free service under the most severe operating conditions, they exceed the requirements for a low cost, efficient power source. Highest volumetric and hydraulic efficiency—rugged simplicity—only two moving parts—the impeller assemblies, which roll together with minimum wear and horsepower loss.

- Pumps operate at higher speeds than most competitive units and permit use of smaller pumps and motors for a given horsepower requirement, thus reducing initial cost.
- The unusual drive design of the impeller gear minimizes wear between the gear and end plates. Pumps are self-lubricated. No grease fittings to service and no external drain required.
- Special shaft seal assures positive sealing, eliminates packing difficulties. Precision gear type construction makes a quieter operating pump. Ratio of volume output to pump size unusally high.

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Write for pump brochure containing complete specifications.

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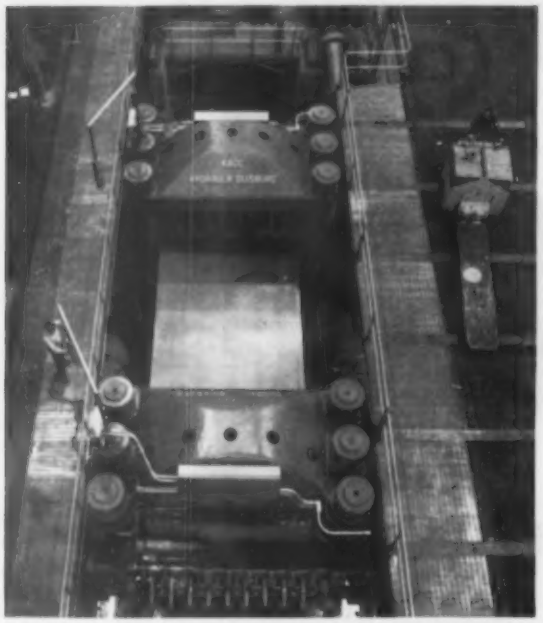
Circle 3 on Time-Saver Card

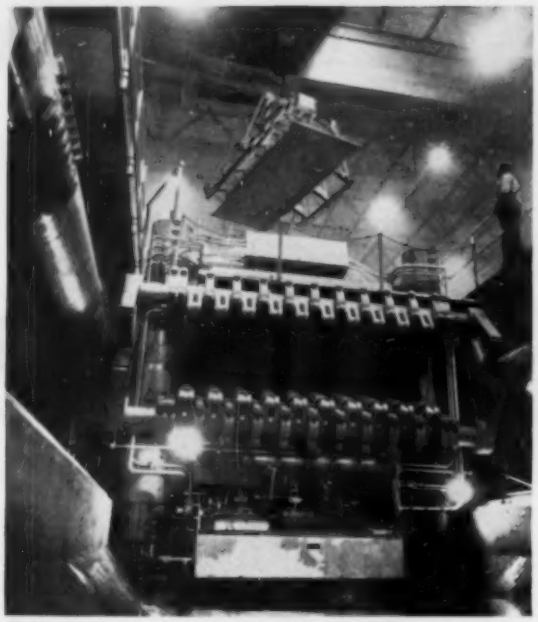
BRIEFS

about fluid power

Machine Stretches Aluminum Plate 4 feet



STRETCHER SITS IN A CONCRETE PIT. 120 x 32 x 15 ft. It has no support or guiding frame. The hydraulic pumps are connected so that the machine stays in parallel regardless of plate position in the jaws.



STRETCHER HAS AN OPEN BACK. The jaws are arranged so that initial pressure removes normal transverse bow before stretching. Jaw flexibility compensates for head deflection and reasonable inequalities in plate thickness.

A plate stretcher at the Ravenwood, W. Va., Works of Kaiser Aluminum and Chemical Corp. can add 4 ft to the length of an aluminum plate 60 ft long. Cross-sectional area limit is 640 sq. in. It develops 30 million lb pull when operated at 6000-psi hydraulic pressure. Stretching refines the metal's internal structure. It equalizes stress distribution in heat-treated alloys and welding alloys.

The two stretching cylinders have 56-in. bores and 4½-in. strokes. Two double acting cylinders with extra-large, double-ended rods adjust the heads to different plate lengths. The double-end rods eliminate many of the pipes and flexible connections used in other equipment of this type. Because of advanced hydraulic design, large piping or prefill valves are not necessary, though often found on hydraulic equipment which operates unloaded, through long tranverse strokes.

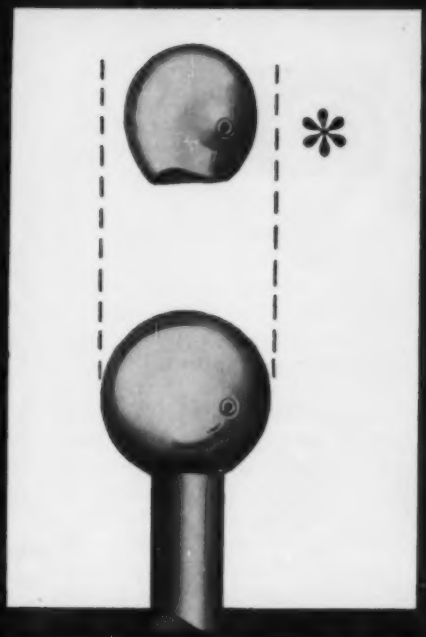
The machine has no supporting or guiding frame. Although power cylinders and columns are in compression, it is free to move on a track. There is no attempt to hold it in fixed alignment.

Four, high-pressure, variable volume pumps power each side of the machine. Two 300-hp motors drive them. The pumps deliver equal volume to each side of the machine. Moving the pumps through center to forward and reverse controls the motion. Maximum stretching rate is one foot a minute.

• **Safety Features**—The greatest forces in the stretcher are those to be absorbed when a plate breaks with the stretcher operating at full capacity. Since the large cylinders are used only for stretching, maximum oil volume

Continued on page 30

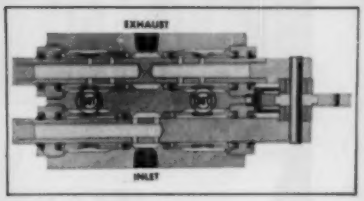
Circle 79 →



after 17 years... replacement parts ***one handle ball!***

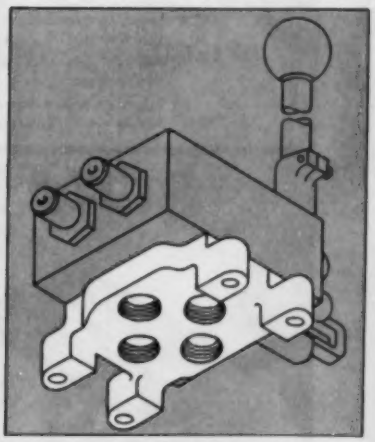
Human hands wore this metal handle ball to a fraction of its original size before the customer returned the valve to us for reconditioning. This high pressure hydraulic valve performed faithfully for nearly two decades with only such minor maintenance as replacement of "U" packing. We replaced the handle ball, repacked it, cleaned it up, and sent it back. This kind of trouble-free service is typical of Hunt hydraulic valves.

¾" MS-551-N4



The Higher the Pressure The Tighter the Seal

Cross-section view shows Hunt system of "U" packing as opposed to "metal to metal". "U" packing provides zero leakage on water hydraulic service.



Sub-Base Mounting Simplifies, Speeds Up Maintenance

New sub-base mounting is now available on all Hunt hydraulic valves. Easy, quick replacement for maintenance with no disconnecting of pipes.

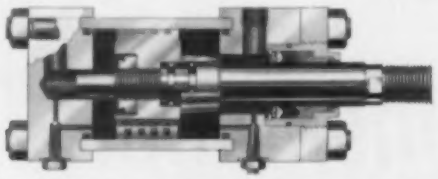
HUNT HV HC HUNT VALVE COMPANY DIVISION OF IBEC SALEM, OHIO

Quick-As-Wink AIR & HYDRAULIC CONTROL VALVES

EXCLUSIVE WITH CARTER!

ROD SCRAPER *PLUS* ROD WIPER AS STANDARD

J. I. C. Interchangeable SQUARELINE Series features a Metal Rod Scraper *plus* a Rod Wiper in a quick change Cartridge—*Double protection* against chips, dirt, damage. Unitized cartridge rod bearing . . . easy removal and replacement . . . no cylinder disassembly necessary!

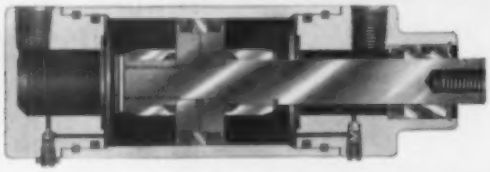


SQUARELINE 2000-3000 PSI HYDRAULIC

- 1½" to 12" bore
- 100% JIC interchangeable
- True cushion-automatic concentric alignment
- Positive piston locknut design
- Delivery from stock!

THE COMPLETE LINE CARTER FLUID POWER

ROUNDLINE AIR-HYDRAULIC



- Space saving designs! Light weight!
- Full 1 to 1 Meehanite cartridge rod bearing.
- Precision honed heavy wall tubing—6 to 1 safety factor.
- Spring loaded "V" packing on rod end gland.
- Key type stainless steel locking ring. Allows 360° orientation of pipe ports.

ROTARY TORQUE ACTUATOR PNEUMATIC-HYDRAULIC

- New design opportunities
- To 370° rotation as standard
- Safe, powerful torque
- Air, oil, gas, water operation
- Zero leakage

STANDARD ROTATIONS

0-100°	0-280°
0-190°	0-370°

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Circle **34** on Time-Saver Card

BRIEFS

under pressure occurs during stretching. In case of a break, oil under pressure bypasses at high pressure, allowing the heads to explode apart for a distance great enough to use up the energy. Because the stretcher floats on its foundation, a break could first occur on one side of the plate. This would release pressure on one column a fraction of a second before the pressure is released on the other. Shock absorbers between the foundation and the end of the column behind the stretcher absorb part of the energy of the moving plates, and realign the stretcher.

Energy within the plate is dissipated in two ways. With the jaws locked on the plate, a break causes the plate and jaw to move apart as a unit. Shortly after the plate moves back into the jaws, they release their grip through wedging action. The plate flies through the open rear of the heads. An outside bumper absorbs the broken plate's impact.

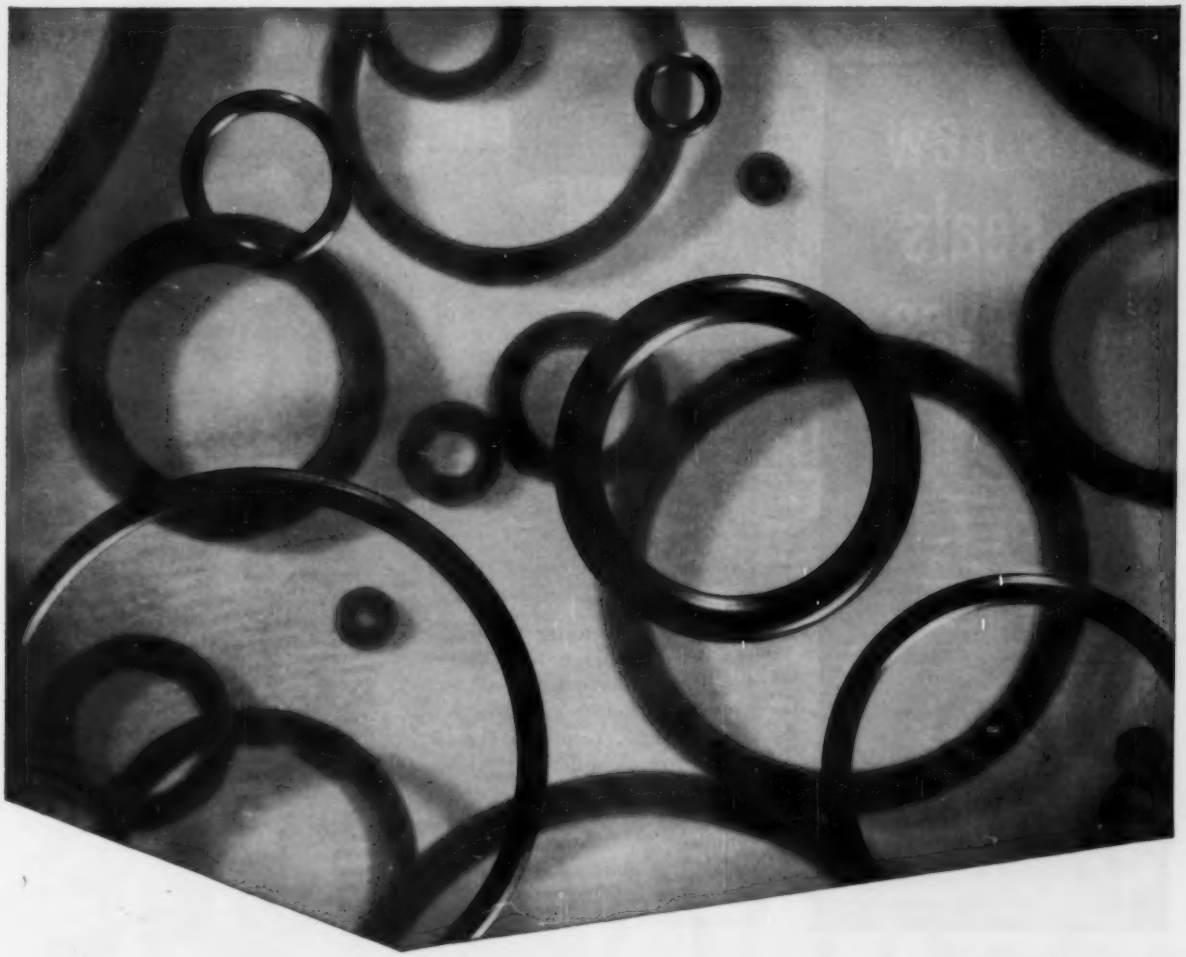
When a plate breaks, the energy transmitted to the jaw before it releases its grip is the most difficult to deal with. The stretcher jaw has a hydro-pneumatic system similar to the recoil mechanism of an artillery piece. It can absorb 15 million ft lb in each head. The slight compressibility of oil removes the initial shock wave from the system.

Hydraulik G.m.B.H., Duisburg, Germany, built the machine for Kaiser. ▼▼▼

Dipping System Takes Less Space

A dipping system for varnish insulation saves 60% of floor space. Conventional systems have a conveyor which dips parts from the preheat oven into a stationary, coil-cooled tank. The tank usually has extra space for gradual work withdrawal and drainage.

Continued on page 32



Bearings, Inc. has "O" RINGS in all materials . . . in all sizes and quantities . . . in stock ready to ship!

Large or small "O" Ring users can get immediate delivery from the nearest Bearings, Inc. branch. "O" Rings for maintenance or for original equipment production. Call a sales engineer from Bearings, Inc. to help you solve any "O" Ring problem — Complete information on all types of "O" Rings is available. Ask for it NOW!

These Materials Available: Standard Buna-N Rubber • Viton • Teflon • Silicone Rubber • Butyl Rubber • Military Spec. Series: MIL P5516A, MIL P5315A, MIL G5510A, MIL P25732, MIL R25897, AMS 7270, AMS 7271 and AMS 7274 • Teflon and Leather Back-up Washers.

All O-Rings Available in Series 6227, 6230, 6290 and 29513.

SELECT "O" RING KITS 180 "O" Rings in Sizes 1 to 25 — All Materials — Priced from $24.50 *(Depending on Material).*

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it's DELRIN*

Another RB&W development from Delrin plastic, this new threaded plug replaces more expensive metal plugs in many hydraulic and compressor applications.

It not only saves on cost and weight, but also does a better job. Fluid pressure forces mating threads together, creates a still tighter seal, locks threads in place.

Metal-like mechanical properties of Delrin provide excellent strength, dimensional stability, rigidity. Count also on resistance to corrosion and solvents.

Available in ⅛, ¼, ⅜, ½" pipe sizes. Send for samples.

Ask about other parts you would like custom-molded from Delrin, or other thermoplastics, in production quantities.

Write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

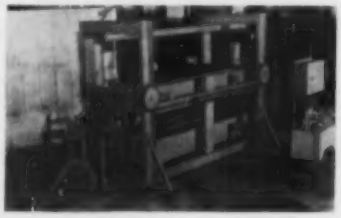
*Du Pont trademark

RB&W
116th year

Circle **142** on Time-Saver Card

BRIEFS

The system developed by R. C. Mahon Co.'s Industrial Equipment Div., Detroit, has two 8' tanks, one over the other. When the conveyor stops over the tanks, it triggers a limit switch. The upper



tank rises to immerse the parts. The lower, storage tank moves downward. After immersion, tanks return. The storage tank acts as a counterweight, keeps the varnish in the dip tank at the proper level, and holds the coils which cool the circulating varnish. A hydraulic cylinder and chains drive the tanks. Hydraulic valving controls speed. Rise, submersion, and withdrawal times are adjustable. ▼▼▼

Hydraulic Unit Has Pressure-Compensated Feed

The hydraulic feed unit attachment operates independently, or in conjunction with other hydraulic equipment such as clamps, indexing mechanisms, or other feed

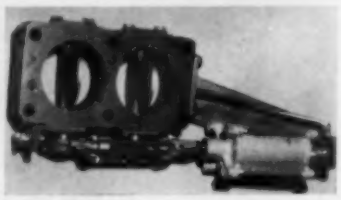
units. Pressure compensated feed valves permit flexible range of work cycles. Fine adjustment makes it useful for reaming, counterboring, grooving, tapping, or other applications requiring an even feed in any part of the stroke.

It sets up easily. Bearings, seals, piston rings, cylinder sleeves, and other components are readily replaceable. All working parts can be taken off the manifold plate without disconnecting the hydraulic lines. The feed unit has a 5/16-in. dia. drilling capacity and an adjustable stroke of 4 in. Maximum hydraulic line pressure is 500 psi with 700 lb of thrust for each 300 psi. Enterprise Machine-Parts Corp., Detroit, Mich. ▼▼▼

Air Operates Compression Brake

The compression brake restricts the exhaust of diesel and gasoline engines, building up a backpressure of 40 to 50 psi in the exhaust manifold. It is independent of air or mechanical brakes. Power Brake Equipment Co., Portland, Oregon, builds the brakes for trucks.

When the truck descends a grade, a butterfly valve closes.



Pressure build-up begins when the foot throttle is released. Each cylinder becomes a low-pressure air compressor. The retarding force against the piston heads is at least equal to the engine's horsepower output. The twin butterfly valve is cast in HH heat-resistant alloy, formulated for temperatures above 1200 F. Strength of the alloy is 33,000 psi at 1400 F. ▼▼▼

Mobile Lab Shows Hydraulics in Action

A mobile display unit, developed by Fluid Controls, Inc., Mentor, Ohio, is a laboratory on wheels. During a 30 minute show in this self-contained and self-powered unit, the demonstrator shows the

Continued on page 34

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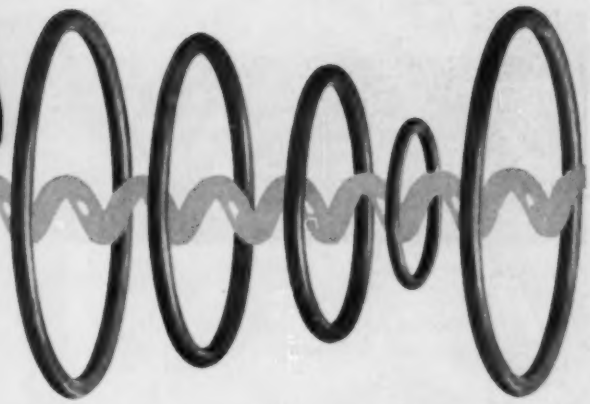
uniform quality
special compounds
on O-Rings



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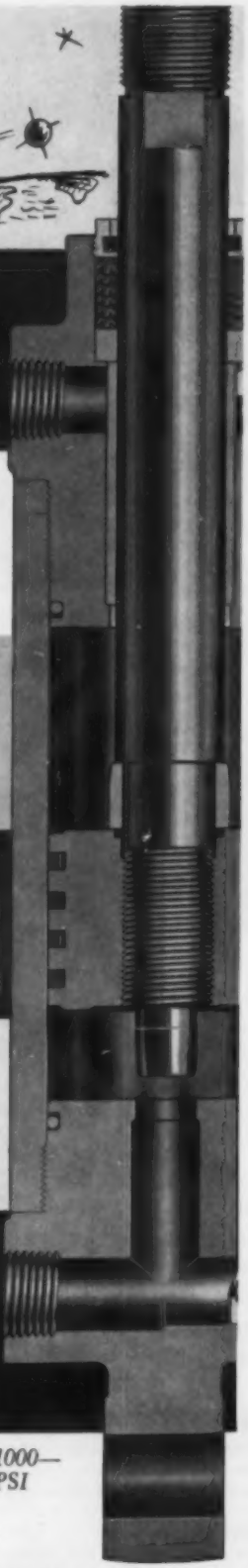
When COMPACTNESS is *IMPORTANT..*

SPECIFY *Pathon* HYDRAULIC CYLINDERS



1 The Pathon single screw thread attaching method gives you extra compactness, low stress concentration, and will withstand high greater shock load.

2 Adequate space between the bearing points gives you increased bearing and rod seal life, reduced power eating friction.

3 The head seal in all Pathon Cylinders is a true static seal, assuring you longer life in operation.

4 Pathon Cylinders have fewer parts, are easy to assemble, disassemble.

5 With Pathon Cylinders you have an extremely wide range of mounting types available to provide almost any mounting position you might want.

Write for further information today.

Pathon Hydraulic Cylinders are available in 1000—2000—3000 PSI and Low Pressure to 200 PSI

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MANUFACTURING COMPANY
3823 PACIFIC AVE., CINCINNATI 12, OHIO
FLUID OPERATED AND CONTROL EQUIPMENT

Circle **125** on Time-Saver Card

BRIEFS

seated audience operation, function, and performance of the company's relief valves, pilot check

valves, and flow regulators. The manufacturer makes this demonstration available as an educational service and should be contacted for the scheduling of this show. ▼▼▼

NFPA News

The second edition of the *Glossary of Terms for Fluid Power*, prepared by the terminology committee of the Technical Board, National Fluid Power Association is now available. This is the second step in the preparation of a comprehensive glossary of terms and definitions for fluid power. It covers 389 terms that have been carefully considered, reviewed and defined by the committee. The committee is composed of educators, users, technical publishers, and component manufacturers interested in the fluid power industry.

• **Dimension Identification Code**—The Board of Directors has approved publication of the recently completed *Dimension Identification Code for Fluid Power Cylinders*. It was prepared under the direction of the cylinder section of the Technical Board after seventeen revisions extending over seven years of study. The publication comprises recommended standards for the location of base points and dimensions of fluid power cylinder diagrams, and

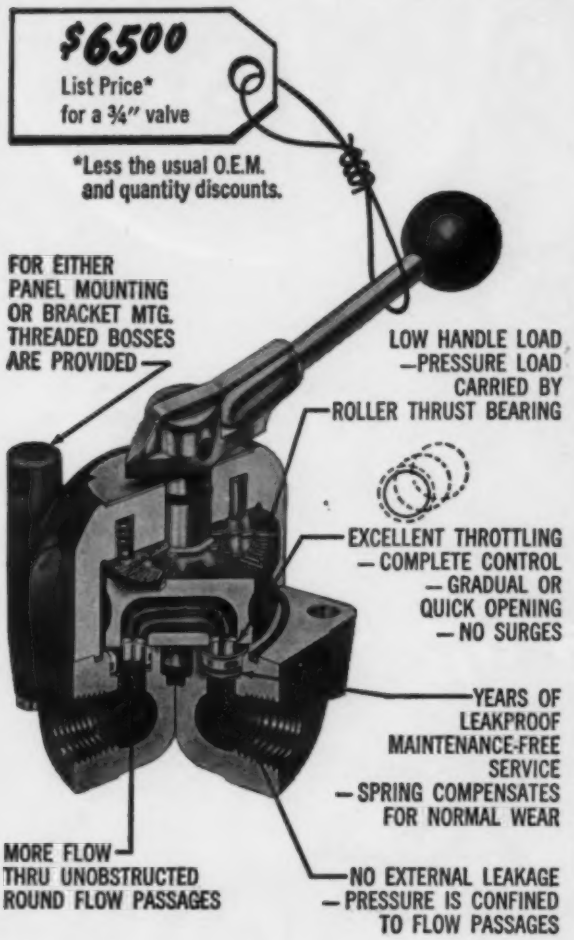
Continued on page 38

NEW!

A "SHEAR-SEAL" VALVE

for LESS than a spool valve

RATED FOR 3000 P.S.I. OIL SYSTEMS


$65.00
List Price*
for a ¾" valve
*Less the usual O.E.M. and quantity discounts.
FOR EITHER PANEL MOUNTING OR BRACKET MTG. THREADED BOSSES ARE PROVIDED
LOW HANDLE LOAD —PRESSURE LOAD CARRIED BY ROLLER THRUST BEARING
EXCELLENT THROTTLING — COMPLETE CONTROL — GRADUAL OR QUICK OPENING — NO SURGES
YEARS OF LEAKPROOF MAINTENANCE-FREE SERVICE — SPRING COMPENSATES FOR NORMAL WEAR
MORE FLOW THRU UNOBSTRUCTED ROUND FLOW PASSAGES
NO EXTERNAL LEAKAGE — PRESSURE IS CONFINED TO FLOW PASSAGES

For complete data on this new valve and for information on all your valve requirements write for Catalog V-59-60

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

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NEW PISTON PRESSURE SWITCH

CONTROLS 2 INDEPENDENT ELECTRICAL CIRCUITS

Really TWO pressure switches for the price of ONE

7000 P.S.I. PROOF

*With calibrated dials (both settings can be made visually without gauges). Without dials $29.50. Both prices subject to the usual quantity and trade discounts.

WE BUILD IN	WE DON'T USE
RUGGEDNESS CAN TAKE SURGES (High proof pressures) CONTINUOUS OPERATION (Millions of cycles) NO STICKING (in dirty fluid)	LINKAGES & BEARINGS WHICH WEAR QUICKLY (cause settings to drift and switch to fail).
LABOR & MATERIAL SAVINGS NO RETURN DRAIN PIPING (Sealed piston) MOUNTS WHERE CONVENIENT (Operates in any position, not sensitive to vibration)	UNSEALED PISTONS WHICH ADD TO YOUR INSTALLATION COST (return piping). ARE CRITICAL TO DIRT (pistons get stuck).

PRESSURE SWITCH DIVISION

Barksdale valves

Send for FREE catalog 9-PS.

5125 Alcoa Avenue, Los Angeles 58, California

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Amweld's main compressed air system and compressors are all tied into a common header. To increase compressor efficiency and reduce condensation in cylinders and air lines, Mobil recommended changes in the location of intake openings, reduced flow rate of jacket cooling water, and increased water flow rate in the after-cooler. Result: an increase of 5% in compressor efficiency, and cooler, drier air in plant lines.

Amweld rings up $14,621

On 8 ring-sizing machines Amweld was experiencing hydraulic difficulties similar to those in the butt welding units. Oil deposits, sticking valves, pump failures, etc. were common problems. 1040 maintenance man-hours a year were required to keep the equipment operating. But again the introduction of a Mobil hydraulic oil and preventive maintenance procedures slashed this labor cost, saved Amweld $2,005 the first year.

On three of Amweld's expander units, brass wear plates on the expanding mandrel were undergoing serious wear. Frequent replacement of these plates, with attendant labor costs, meant a $3,936 expenditure for Amweld in one year alone. Studying the problem, Mobil Engineers recommended an extreme pressure grease. In the year since this Mobil product was introduced, not a single replacement has been made.

savings with Mobil!

A leading producer of welded rings, American Welding & Manufacturing Co. cuts maintenance costs with Mobil Lubricants and engineering service.

Specializing in the production of welded rings, bands and assemblies, American Welding has developed methods and techniques for precision-welding alloy steels and non-ferrous materials in both light gauges and heavy sections. Parts are supplied "as-welded," or machined and finished, to prime contractors, and include components for jet engines and missiles.

Critical tolerance requirements demand rigid maintenance procedures at Amweld. And Mobil products and engineering service have made significant contributions in terms of minimized machine downtime and consistent savings in lubricant and parts costs. Working in close cooperation with Amweld technical personnel, Mobil has made recommendations that have saved this producer $14,621.

Mobil's extensive background in lubrication may help you achieve similar savings in your plant. Your Mobil Representative is the man who can tell you.

Mobil

CORRECT LUBRICATION

MOBIL OIL COMPANY, 150 E. 42nd St., New York 17, N.Y.

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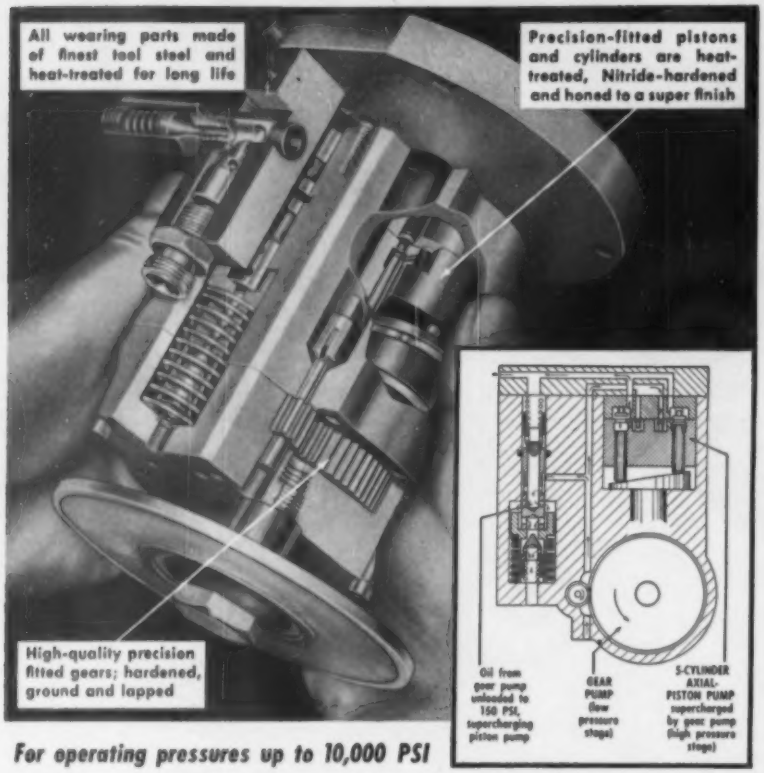
All wearing parts made of finest tool steel and heat-treated for long life
Precision-fitted pistons and cylinders are heat-treated, Nitride-hardened and honed to a super finish
High-quality precision fitted gears; hardened, ground and lapped
Oil from gear pump unloaded to 150 PSI, supercharging piston pump
GEAR PUMP (low pressure stage)
5-CYLINDER AXIAL-PISTON PUMP supercharged by gear pump (high pressure stage)

For operating pressures up to 10,000 PSI

New, unique 2-stage hi-pressure hydraulic pumping unit—dual-volume, dual-pressure

- **DELIVERS HIGH-VOLUME AT LOW PRESSURE**
- **2.6 GPM @ 100 PSI**
  1.75 GPM @ 500 PSI
  80 CU. IN./MIN. @ 1,000 PSI
  50 CU. IN./MIN. @ 10,000 PSI

The new and modern OTC "Vanguard" hi-lo hydraulic power package is a precision-built, high-quality unit meticulously crafted for dependable performance and long life. To best utilize the "Vanguard's" exceptional performance, a wide range of accessories are available: your choice of several motors, gasoline engine, 2 and 4-way lever-control valves, 2-way solenoid valve, pressure switch, pressure regulating valve, manifold, reservoirs, gauges, etc.

For detailed information on this advanced, new unit, write:

PRECISION HYDRAULICS DIVISION
OWATONNA TOOL CO.
710 CEDAR STREET OWATONNA, MINNESOTA

RESEARCH · ENGINEERING · DEVELOPMENT
OTC

DESIGNERS AND MANUFACTURERS OF QUALITY HIGH PRESSURE HYDRAULIC COMPONENTS

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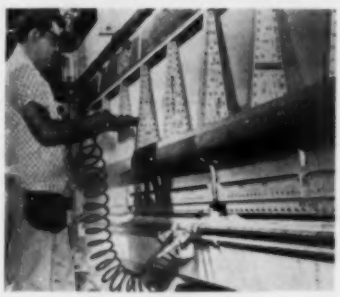
BRIEFS

a code of letters for designating dimensions. The recommendations cover various types of mountings, and can be applied to all cylinders regardless of type of construction.

Both publications are available at $1.00 each from National Fluid Power Association, 5595 North Hollywood Avenue, Milwaukee 17, Wisconsin.

• **Fall Meeting Plans**—The 1960 Fall meeing of the Association will be held October 31 to November 2 at the Edgewater Beach Hotel, Chicago. Emphasis will be on marketing and technical subjects. There will also be reports and discussions by the Management Services Board and the Public Relations Board.



COILED NYLON AIR HOSE stretches and recoils like a telephone cord. Cord is illustrated in operation with an air hammer on a wing sub-assembly. The light-weight, compact coil can be connected to air lines with quick-disconnect fittings, and carried from job to job. Hose is oil resistant, processed to return to its retracted, coiled shape. Made by Nycoil Co., Westfield, N. J.

Instead of following the format of past programs, which usually scheduled several speakers, the Marketing Board has arranged a series of workshops covering such subjects as manufacturer-distributor relations, sales management, marketing administration, and statistical service.

The technical board program will have the theme: *Rating Methods*. There will be separate workshops for manufacturers of pumps,

Continued on page 41

The most efficient compressed-air-line filter you can buy...

New, perfected-design Norgren Air-Line Filters give you these benefits:

1. Complete liquid removal.
2. Highly effective removal of solids.
3. Choice of 4 interchangeable filter elements to best suit your requirements—5, 25, 64, 74 microns.
4. New, stronger transparent bowl.
5. Larger bowl capacity and larger quiet zone for trapping collected liquid.
6. Improved baffle design prevents return of liquid to air line.
7. Quick, easy cleaning—no tools needed—only 4 parts to handle.

Where safety regulations require protection for bowls *from external physical damage—a removable metal bowl guard is available.*

Founded in 1926

C. A. NORGREN CO.

3402 SOUTH ELATI STREET
ENGLEWOOD, COLORADO

Norgren Filter removes <u>all</u> liquid from compressed air

The improved design of the new line of Norgren Filters provides a greater than ever liquid removal efficiency—removing all liquids over the entire range of recommended air flow. Removal of abrasive solid particles is also highly effective.

New, stronger transparent bowl is an important feature of the new filters. This bowl has a higher safety factor than ever before and a much greater resistance to fatigue.

The bowl has a larger capacity for collected liquid. The "quiet zone" below the baffle holds 53% more collected air-line contaminants—requires less frequent draining.

Servicing is easier and quicker. No tools are required to disassemble the filter for cleaning, and there are only four separate parts to handle.

For complete information about the money-saving features of the Norgren complete line of manual drain and automatic-drain filters, call your nearby Norgren Representative, listed in your telephone directory—or **WRITE FOR BROCHURE NA-1.**

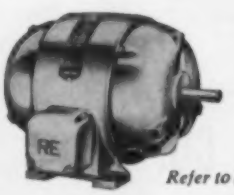
"Molded Horsepower" to fit your equipment

...no longer must you "make something do!"

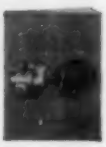
Just as a famous artist molds each illustration to his need... so, too, can you now have an electric motor exactly tailored to the needs of your equipment. Not just another motor that can be "made to fit" but a complete power package with all desired electrical and mechanical characteristics built right in.

Reuland "Molded Horsepower" is a natural outgrowth of the famous "Xpandable" design idea originated by Reuland many years ago. Through this technique, motors, brakes, fluid couplings, gear reducers and similar devices are available in an almost unlimited number of combinations... all standard units assembled within a single frame and tailored to your specific application.

Only Reuland offers such a wide background of experience in tailored power packages. No wonder Reuland is also the "number one" supplier to many of the top original equipment manufacturers in America!



Our new 8-page catalog, No. GS8-30-0, will come in handy. Sent complete with prices and engineering drawings on request.



Refer to Sweet's Product Design, Section 5-a

MODERN POWER FOR MODERN-DAY PRODUCTS

... all in lightweight, cool-running aluminum frames!

REULAND MOTORS

REULAND ELECTRIC COMPANY
WESTERN DIVISION: *Alhambra, Calif.*
EASTERN DIVISION: *Howell, Mich.*
Distributors in all principal cities

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BRIEFS

valves, cylinders, accumulators, and fluid conditioners. At the general session, reports will be presented on classification index system, fluids, terminology, and publications. Marketing and technical workshops will be concurrent.

Non-members desiring to attend the Fall Meeting are requested to contact Barrett Rogers.

• **Marketing Code Planned**—Plans for reorganizing the Marketing Board, proposed at the Point Clear, Ala., meeting last May, have been accepted by board members with much interest. They have held two full-day meetings since then with excellent attendance, and much work accomplished.

Many projects are underway. One that is receiving much attention is to improve manufacturer-distributor relations, primarily for the benefit of the customer, by exploring problems that now exist, and recommending corrective measures. It is planned to prepare a code of recommended practices through the joint efforts of the three interested groups—manufacturers, distributors, and users.

Also underway is an extensive market analysis that will explore

Continued on next page

BRIEF NOTES

CRYSTALLINE FIBER INSULATION . . . that can be used up to 2200 F offers low heat conductivity. Du Pont's "TIPERSUL" can be used for thermal, accoustical, electrical and filtration applications.

1960 WESTERN TOOL SHOW . . . Booklet tells about ASTME's meeting in the Los Angeles Sports Arena, on Nov. 14-18. Gives general information, names of exhibitors, booth locations and numbers. Available from American Society of Tool & Manufacturing Engineers, 10700 Puritan Ave., Detroit, Mich.

THIRD EXPANSION WITHIN A YEAR . . . was recently completed by Hydraulic Unit Specialties Co., Waukesha, Wis. The latest addition has toolroom facilities and a testing and quality control laboratory.

THE "ROSS ENGINAIR" . . . published by Ross Operating Valve Co., Detroit, was rated the most outstanding company publication in an annual advertising agency competition. An educational and promotional magazine on compressed air technology and control, it is produced by Clark and Bobertz, Inc., Detroit.

1ST NATIONAL DIE CASTING EXPOSITION & CONGRESS . . . will be in the Detroit Artillery Armory, November 8-11. Exhibitors will be suppliers to the die casting industry, independent die casters, and captive die casting plants.

BUSINESS BRIEFS

CLARK ENGINEERING AND MANUFACTURING . . . was recently purchased by Weatherhead Co., Cleveland, Ohio. All design, engineering and manufacturing of the Clark Line of directional control valves will be moved to Cleveland, according to A. J. Weatherhead, III, vice president and general manager of the Cleveland operation.

1959 FILTRATION BUSINESS . . . in the U. S. was $300 to $350 million at the manufacturing level. This represents an increase of three times the pre-war level, and an annual rate of growth averaging 12%. Chief markets are automotive, air, water and industrial filtration and military business.

MACHINE TOOL SHIPMENTS . . . totalled $265,900,000 during the first six months of 1960, an increase of 41% over the first half of 1959. Net new orders of $257,450,000 show a gain of 9%. Metal forming tool sales amounted to $72,650,000, up 21% over a similar first six months period of 1959. Foreign net new orders for metal cutting and forming tools combined, amounted to $88,700,000, or 26% of total net new orders.

HIGH PRESSURE IS
AVAILABLE

Dynex supplies complete circuits from 1 to 90 hp in pressure ranges to 6000 psi. A comprehensive design and application engineering service is available to help you apply standard Dynex pumps, motors, valves and cylinders or create special components tailored to your specific circuit requirements for OEM applications. Investigate the many advantages of high pressure hydraulic circuitry. It is available from Dynex . . . now. Ask for bulletin DG-3 which summarizes standard products available.

dynex INC.
A DEVELOPMENT OF BLACKHAWK
IS HIGH PRESSURE
777 DYNEX DRIVE • PEWAUKEE, WISCONSIN
HYDRAULIC PUMPS • VALVES • MOTORS • CYLINDERS • CIRCUITS

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An RMC thermometer is shown below as installed in Atlantic Refinery's Philadelphia Synthetic Ammonia Plant. RMC's superior dampening process provides the stamina necessary to meet the sustained accuracy requirements of operations such as this.

RMC dampening process insures sustained thermometer accuracy

RMC dial thermometers are thoroughly dampened with silicone on the bimetal element and a special precision-machined bearing on the shaft. The combined use of this dampening bearing *and* silicone makes RMC thermometers extra resistant to shock and vibration.

Facts you should know about proper dampening of bimetal thermometers

It is generally assumed that bimetal dial thermometers are dampened merely to prevent pointer oscillation when used on vibrating equipment. True, the prevention of pointer oscillation is necessary, but there are more important reasons for the use of dampening.

The primary reason is to preserve accurate calibration, especially in the lower temperature ranges where a thinner bimetal element is used. An *un*dampened bimetal element, when subjected to shock or severe vibration, would have a tendency to unwind slightly and throw the instrument out of calibration.

To prevent this, RMC thermometers are dampened by a patented process in which the bimetal element is coated with silicone. The silicone provides permanent protection for the critical bimetal element, holding the coil in place and preventing any unwinding or shifting action—thus helping to maintain calibration accuracy.

But RMC goes one step beyond silicone, with a specially designed bearing which even further dampens both shaft and coil. The bearing also serves as a better guide for the bimetal shaft to keep it perfectly aligned within the tube. Only RMC uses this extra dampening device in addition to silicone and the usual guide bearings.

It is the combined use of the special dampening bearing *and* silicone that makes RMC thermometers extra resistant to shock and vibration. You get this *only* in RMC industrial thermometers.

Write, wire or phone for general catalog. If yours is a special application, tell us your requirements—RMC engineers will work with you in solving it. Rochester Manufacturing Co., 209 Rockwood St., Rochester 10, N. Y. (Telephone: BRowning 1-2020).

RMC

LIQUID LEVEL TEMPERATURE and PRESSURE INSTRUMENTS

ROCHESTER MANUFACTURING CO., INC., Rochester, N. Y.

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BRIEFS

the many user groups listed in the Standard Classification Code of the U. S. Department of Commerce. This will cover all markets; aerospace, mobile, construction, farm machinery, and the many industrial classifications.

Other projects include marketing administration, government regulation affecting distribution, sales management, sales statistics, product planning, the preparation of a marketing manual. All of them will be reported on at the Fall meeting.

• **Single SIC Numbers for Fluid Power**—A special committee of the Management Services Board is conferring with the Business and Defense Service Administration to obtain a single Standard Industrial Classification number for the fluid power industry, to simplify obtaining controlled materials under emergency regulations. ▼▼▼

FPS News

Applications for membership in the recently organized Fluid Power Society are being received at a very gratifying rate. Along with individual applications, there are many requests for information on the organization of local Chapters. It is expected that by the end of 1961, there will be local units in all of the principal cities of the United States and Canada.

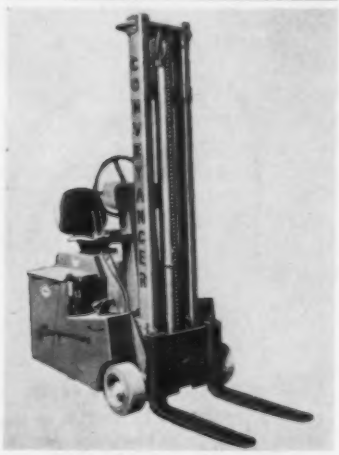
Chapters are operating in Detroit and Milwaukee, and planning activities are under way in Cleveland and Chicago. Other chapters forming are Baltimore, Minneapolis, St. Paul, Dallas, Los Angeles, San Francisco, Cincinnati, Pittsburgh, Denver, Wichita, St. Louis, Toledo, Rochester and Indianapolis. Much interest has been expressed by members of the industry in Canada and probably there will be chapters organized in Canada within the next few months. Inquiries have been received also from Australia.

Ten members are required to form a chapter. More information is available from executive vice president, Barrett Rogers, 5595 N. Hollywood Avenue, Milwaukee 17, Wisconsin.

• **First Annual Meeting**—The first annual meeting of the Society will be held Wednesday, October 19 at the Hotel Sherman, Chicago. This is the day before the National Conference on Industrial Hydraulics to be held at the same location. The date was purposely selected to enable interested persons to attend both meetings.

In addition to a general session in the afternoon, there will be a meeting of the House of Delegates and the Board of Directors.

Non-members of the Society are invited to attend the general session, without payment of registration fee, so that they may become better acquainted with the Society, its purposes, operations, and benefits.



AN OPEN-CENTER HYDRAULIC SYSTEM is designed into this British fork lift truck. A multiple valve bank controls all the cylinders allowing one valve for each circuit. A single acting cylinder, anchored at the mast base, lifts and lowers the forks. A flow control valve in the circuit limits the lowering speeds of the load. A double acting cylinder mounted on a ball bearing actuates the mast tilting action. The truck was developed by Fork Trucks Ltd., Warrington, England.

• **Local Chapters Organize**—Detroit Chapter No. 1 met on September 23 at the Ford Sterling Plant in Detroit. Wives of members also attended as special

Continued on next page

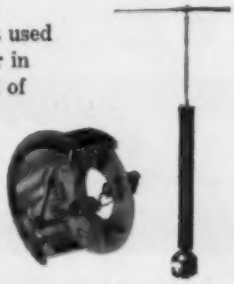
The photograph below shows RMC Pressure Gauges undergoing severe vibration testing on big Calidyne High Frequency Vibration Test System. These gauges undergo accelerated tests from 0-2000 CPS—up to 25 G intensity and up to 350° F.

RMC *direct-drive* Pressure Gauge eliminates vibration problems

The RMC *direct-drive* Pressure Gauge is rugged and resilient. It is the first direct-drive helical bourdon gauge—inlet pressure acts directly on a helical bourdon to drive the pointer. The helical coil, as a simple spring, is resilient and fully balanced, and is not affected by shock or vibration.

With its direct drive, there are no gears or linkage to gyrate and score on vibration—no unbalanced bourdon "C" springs and hair springs to whip. Direct-drive action means a stable pointer—no loss of power, too. Pointer action of the RMC gauge is steady, positive and alive—no need to tap the gauge to read. Soft hair springs and backlash springs are not used.

Shown at far right is the pointer-coil unit used in 3″ and 5″ concentric models. The pointer in these models is attached directly to the end of the pressure element. At the near right is a cutaway view of the compact 1½″ and 2″ eccentric models. The pointer in these models is actuated directly by a simple pivot. Both types offer the same direct-drive, helical bourdon advantages. Pressure ranges from 0-1000 to 0-10,000 psi.



Write, wire or phone for general catalog. If yours is a special application, tell us your requirements—RMC engineers will work with you in solving it. Rochester Manufacturing Co., 209 Rockwood St., Rochester 10, N. Y. (Telephone: BRowning 1-2020).

RMC

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

ROCHESTER MANUFACTURING CO., INC., Rochester, N.Y.

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jamesbury

"Double-Seal" Ball Valves

STYLE "H" SERIES HIGH PRESSURE

3000 TO 4500 P. S. I.

"Double-Seal"™ BALL VALVES

- Pressure range: high vacuum to high pressure
- Virtually leakproof and indestructible in service
- Temperature range:—320°F to +400°F*
- Eight sizes ¼" through 2"—available in both pipe and tubing threads
- On-Off service, quarter-time, full flow construction

[redacted]

. . . a unique, compact, single-piece body of rugged design which permits wide high-pressure, high-vacuum applications, especially recommended for hydraulic equipment and the handling of compressed gases or hazardous fluids. Cryogenic (low temperature) uses are also feasible with extended bonnet adaptation. Available in Straight Tubing or Standard Pipe Thread as catalog items. Flanged valves available on special order.

[redacted]

¼ In. — ½ In.
4500 PSI (—20°F to +160°F)

¾ In. — 2 In.
3000 PSI (—20°F to +160°F)

[redacted]

Jamesbury Style "H" Double-Seal Ball Valves are available in Carbon Steel, 303 and 316 Stainless Steel.

"TEFLON", Special Nylon or synthetic rubber seats and seals.

*Selection of valve seats and seals determine the temperature and pressure ratings.

Write for Materials and Pressure Specification Sheets for Style "H" series for performance data.

* Patented

JAMESBURY CORP., 72 NEW STREET, WORCESTER, MASS.

Distributors in Principal Cities

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BRIEFS

guests. One of the highlights of the evening was presentation of Detroit's Charter as Chapter No. 1 of the Society.

Following meetings of the steering committee, the Milwaukee chapter held its first formal meeting on September 29 at the Milwaukee School of Engineering. The following slate of officers were presented by the nominating committee to serve until July 1, 1961: President, Russell Henke, Racine Hydraulics; Vice President, Dudley Pease, Dynex; Secretary, Mel Striegel, Milwaukee School of Engineering; Treasurer, Jim Price, Price Engineering.

Frank Mackin of General Motors Institute, and national president of the Society, presented the chapter with its charter. Plans call for cooperation with the Milwaukee School of Engineering on a servomechanism symposium early in December.

Chicago plans are underway to hold an organizational meeting at the American Institute of Engineering and Technology under the leadership of Dean Milton Goldstein. There is so much potential

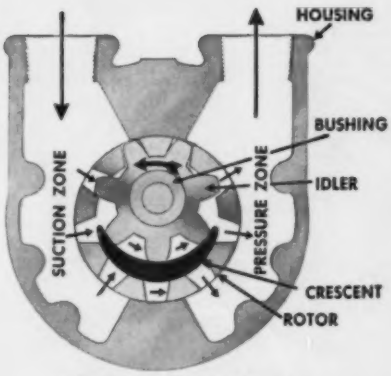
Continued on page 46

LOW PRESSURE AIR PRESS to mass produce blister packaging, was announced by the Jackmeyer Corp., New York, N. Y. This machine uses no heat and only 5 to 10 psi air instead of the common 80 to 100 psi. No heat and low pressure make this blister-packaging method useful for heat sensitive products.

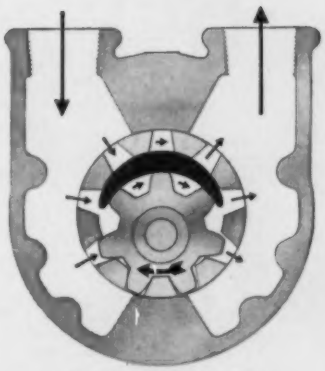
The TUTHILL Internal Gear Pump... and its advantages in reversing applications

by E. H. Schanzlin,
Chief Engr., Tuthill Pump Co.

Extremely high reliability, proven in thousands of applications over a 30 year period, has made Tuthill's internal gear pump an industry standard. The Internal gear construction particularly adapts itself to reversing pump applications as indicated in the sketches at right.



COUNTERCLOCKWISE ROTATION


CLOCKWISE ROTATION

How It Operates

Key elements are the rotor, idler gear and the crescent shaped partition. This crescent shaped partition, shown in heavy black, is cast integral with a moving part called the idler carrier.

In the drawing at left, power is applied in counterclockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the rotor is sealed by the crescent. When the pump is started, there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent to the pressure side of the pump. When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port.

When shaft rotation is changed from counterclockwise to clockwise, as in the drawing at right above, the idler carrier, (including the idler gear and crescent) automatically rotates 180° through the suction zone. This changes the directional flow within the pump without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that the crescent can rotate only 180° —always through the suction zone. If rotation were again reversed to counterclockwise, the crescent would swing back to its original position (shown at left above).

No valves required . . . ports remain constant

This unique construction permits positive reversing action, without any valves, and with the port positions remaining constant. In addition Tuthill's reversing pumps provide all the other attributes of internal gear construction . . . extremely high reliability, compactness, and high efficiency.

Reversing Pumps with internal gear construction pay particular dividends on applications where the pump must be driven from a reversing shaft or when machinery must be shipped without knowing the ultimate direction of the driving unit.

375 reversing pump models

Tuthill offers a complete selection of over 800 different pumps including 375 different reversing pump models for capacities from ⅓ to 200 GPM; for pressures to 400 PSI; and speeds to 1800 RPM. These include a complete selection of stripped models for incorporation into products. Specially designed housings, shaft extensions, relief valves and many other features can be developed by Tuthill's engineers to meet the requirements of specific applications.

Catalog 105 contains complete information on all Tuthill Reversing Pumps. Write today for your copy.

Typical Tuthill Reversing Pump. Model 2RC has capacity of 5 GPM operating at 100 PSI, 1200 RPM.

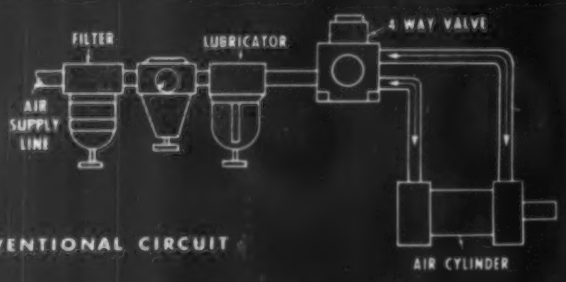
Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 GPM; for pressure to 300 PSI; speeds to 3600 RPM.

PUMPS FOR YOUR PURPOSE

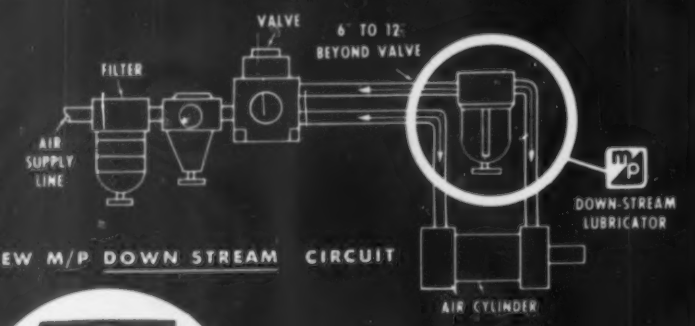
TUTHILL PUMP COMPANY

981 East 95th Street, Chicago 19, Illinois

NEW m/p CONCEPT
OF AIR CYLINDER LUBRICATION



CONVENTIONAL CIRCUIT



NEW M/P DOWN STREAM CIRCUIT

DESIGNED SPECIFICALLY FOR AIR CYLINDERS

With a conventional circuit the air cylinder may not be lubricated because oil introduced by the lubricator is trapped in the valve and exhausted to atmosphere. Any small amount of oil that works through the valve may also be exhausted when the cylinder is reversed.

Now . . . M/P has developed a new concept of air cylinder lubrication. The new Lubricator (Model M204) installed in the *Down-Stream Circuit* assures lubrication of both the control valve and the cylinder.

Contact your local representative or M/P for a detailed brochure.

HYDRO-JECTOR
Automatic drain valve that can be installed easily in the bottom drain port of any compressed air filter, drain leg or surge tank.

SHATTER-GUARD
A new feature which makes the M/P *Visi-Bowl* as safe as a metal bowl. Available on all M/P Filters, Lubricators and *Hydro-Jectors*.

MASTER PNEUMATIC, INC.
20430 SHERWOOD • DETROIT 34, MICHIGAN • Phone: TWinbrook 3-7070

Circle **106** on Time-Saver Card

BRIEFS

in this area that much thought is being given to the question of which is better—one large chapter with several sections each with its own field of interest, or more than one chapter each serving a different geographical area or field of interest.

• **Cleveland Activities**—The decision to organize a Cleveland Chapter was the result of a meeting held August 30 at the Cleveland Engineering Center. Forty-five men attended the meeting.

THIS MACHINE PRODUCES more than 300 vane pumps per hour for Chevrolet power steering systems. It assembles 41 parts in 21 different operations. Each pump is tested for leakage and functional performance before shipment. Designed by Swanson-Erie Corp. Erie, Pa.

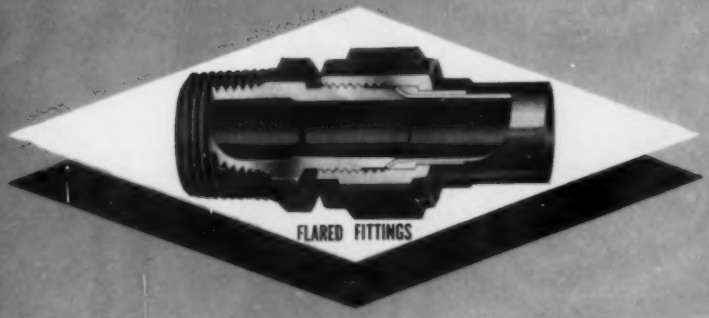
After an enthusiastic discussion on purpose and future activities of the Society, a show of hands indicated unanimous support of a local chapter.

A steering committee was selected to choose a slate of officers and plan a program for the coming year. The committee includes Allan Morris, editor of HYDRAULICS & PNEUMATICS as chairman, John Demian, Marquette Div. Curtiss-Wright; John McAfee, Chevrolet Div., General Motors; Ted Budzich, Design Consultant; Barry Evans, Universal Hydraulics; Peter Spuhler, Hunt Valve; B. R. Teree, Republic Manufacturing, and Norman Paquin, Paquin Co. First meeting of the steering committee is planned for September 20. Cleveland promises to be one of the larger chapters as it will probably draw from many close-in cities. ▼▼▼

Circle 4 →

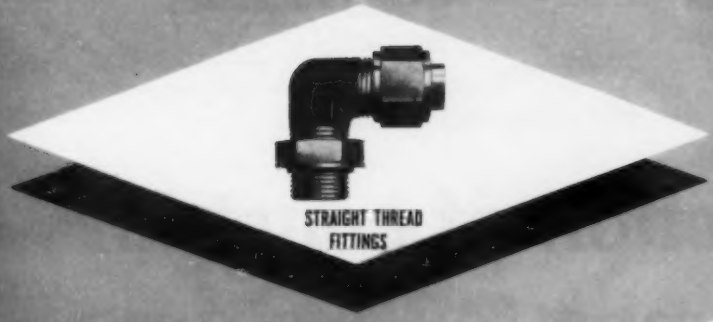
AFCO

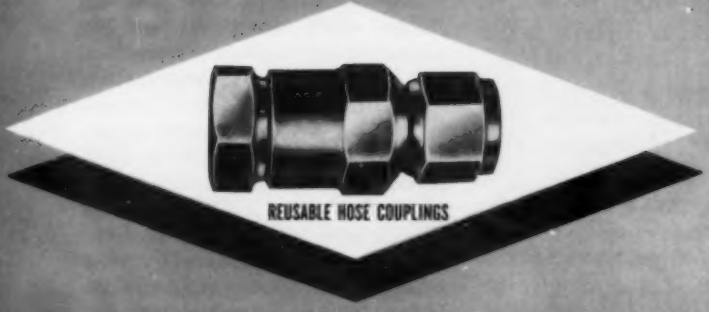
INDUSTRIAL HYDRAULIC FITTINGS



TUBE FITTINGS

TO J.I.C. HYDRAULIC STANDARDS





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Proper selection of constant Hydraulic Pumps for systems

By: Ellis H. Born
Director of Sales-Engineering
Denison Engineering Division
American Brake Shoe Co.
Columbus, Ohio

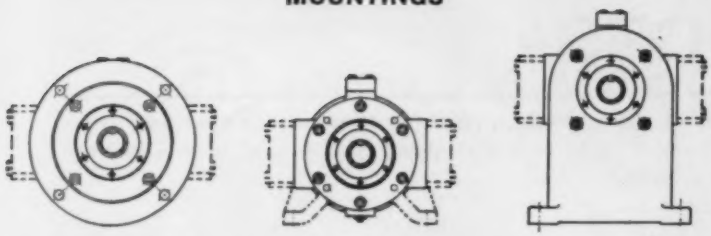
Whether to use a high pressure system or a low pressure system is perhaps the most basic decision the designer faces in developing the proper hydraulic system. This decision involves such factors as efficiency, space requirements and, most important, cost.

SPACE CONSIDERATIONS

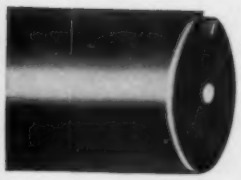
Furnishing fluid horsepower is the function of a hydraulic system. Horsepower yield is determined by multiplying system pressure (psi) times flow rate (gpm) times a constant of 0.000583. Application of this formula reveals that a 5000 psi system develops five times the horsepower of a 1000 psi system at the same rate of flow. Accordingly, the 5000 psi system requires only 20% of the flow rate of a 1000 psi system to produce the same fluid horsepower.

Reduced rate of flow permits designs which incorporate smaller valves, piping, hydraulic cylinders and reservoirs. Since reservoirs are often the largest single fluid component in a system, appreciable space savings can be realized with high pressure systems. If recommended hydraulic practice is followed, reservoir capacity is three times greater than the gpm displacement of the pump. Hence, for the same amount of fluid horsepower, reservoir capacity can be reduced as much as 80% in a high pressure system. The high

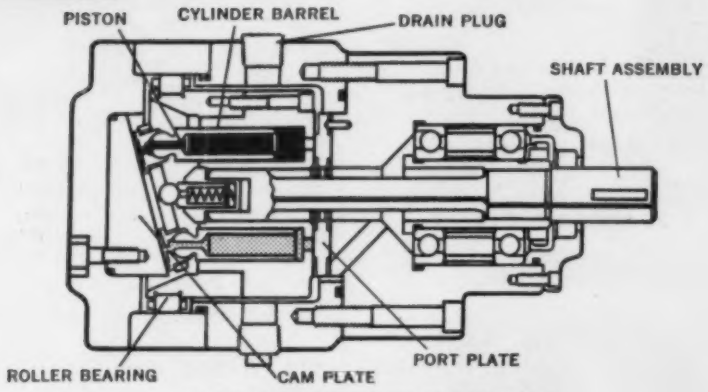
MOUNTINGS



FLANGE **FACE and PEDESTAL** **BRACKET**



Denison constant volume axial piston pumps offer volumes up to 122 gpm, pressures to 5000 psi, at their rated speeds of 1200 and 1800 rpm. Face, flange, bracket or pedestal mountings are available for ready adaptation to your particular installation. Models are available for either clockwise or counter-clockwise rotation.



DETAILS OF CONSTRUCTION

volume Axial Piston up to 5000 psi

pressure system not only allows savings in space through use of smaller components and capacities, but reduces the weight and mass of the hydraulic power package as well.

COST FACTORS

Use of smaller components in high pressure systems not only saves space, but affords worthwhile cost reductions.

Compact system elements cost less and because they are smaller, as well as lighter, assembly is easier and faster. Raw material requirements are also reduced. These advantages permit the over-all hydraulic system design to incorporate less weight and mass. The latter is especially important where portability is concerned.

SYSTEM EFFICIENCY

In any hydraulic system, a part of the generated fluid horsepower is used to force fluids through the system. Resultant line and pressure decreases are far less significant in high pressure systems. For example, a pressure drop of 50 psi represents a loss of 5% in a 1000 psi system, but only a 1% loss in a 5000 psi system. It follows that high pressure systems have an inherent efficiency advantage over low pressure systems.

The ability to provide sustained efficient power for a high pressure system is best fulfilled by a precision-built axial piston pump because of its low slippage rate and operating characteristics.

All internal forces created by hydraulic pressure against the moving parts are counteracted by the use of hydraulic balancing.

Using the principle of hydrostatic balancing eliminates the need for expensive and often cumbersome thrust bearings in the pump. This design minimizes pump size and allows a more compact pump or fluid motor package.

Other advantages are gained through hydrostatically balancing pistons and the cylinder barrel. For example, excessive loading of piston shoes against the cam plate is avoided. In addition, excessive loading of the cylinder barrel against the port plate is prevented, virtually eliminating wear caused by sliding action.

Life expectancy of internal axial piston pump parts is almost infinite since constant lubrication is supplied by system fluid.

Data and specifications on 5000 psi pumps, motors and controls are available from your Denison representative—located in principal cities—to assist you in developing hydraulic systems for maximum efficiency and economy.

NEW CATALOG FOR DESIGNERS AND ENGINEERS

Write for your copy of Bulletin 220—"Hydraulic Power to 5000 psi". Includes complete specifications, operating data and applications for Denison's full line of hydraulic pumps, motors and controls.

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1166 Dublin Road • Columbus 16, Ohio

NEW PRODUCTS

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

10,000-PSI VALVE

Free-flow metering valve maintains ram pressure after power has been turned off. Moving valve control clockwise holds ram pressure. As

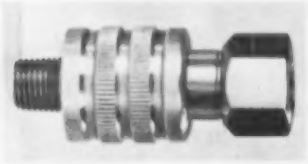
control handle is turned counter-clockwise, valve controls ram's return speed. It allows oil to return freely or at an adjusted rate.

Designation: No. 1724A—*Greenlee Tool Co., Rockford, Illinois*

Circle **300** on Time-Saver Card

SLEEVE VALVE

Automatically controls single-acting, spring-return air cylinders. On-off valve is 3-way, 2-position. Installs in any position, on production line, on machinery, or on cylinder. Eight air-passage holes for low friction loss and high capacity.



Specifications: Valve is 2¾" long x 1⅝" dia.
Airmatic Valve, Inc., Cleveland.

Circle **301** on Time-Saver Card

PULSATION ELIMINATOR

Reduces pump pulsations to 1% or less of system pressure. Traps noise. No moving parts. No elastomer or flexible seals. Compatible with all liquids. It has a chamber tuned to specific pump frequency and flow rate. Baffle system splits flow and shifts phase of one-half of the flow so that pulsation is reduced when flow rejoins at filter's delivery end.

Specifications: Unlimited flow ranges. For working pressures to 25,000 psi, temperatures from −450 to 1000 F.

Designation: High Pressure Ripple Filter—*Auto-Control Laboratories, Inc., Inglewood, Calif.*

Circle **302** on Time-Saver Card

10 & 20-MICRON FILTERS

Made of resin-impregnated cellulose, backed with perforated steel

cylinder. Reinforced by three supporting rings, spotwelded in position.

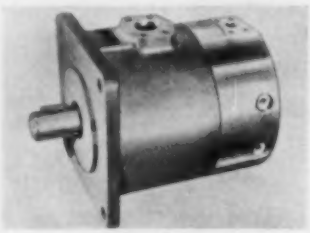
Specifications: 20-micron element handles 100 gpm at 1 psi. 10-micron element handles 100 gpm at 2½ psi—based on 150 SSU. 20-micron element handles 100 gpm of 500 SSU at 4-psi pressure drop. Provides protection during cold starts. Used in housing with 125 psi working pressure.
Rosaen Co., Hazel Park, Mich.

Circle **303** on Time-Saver Card

AXIAL PISTON PUMPS

Independent, multiple circuitry with one pump. Integral check valve allows straight flow path from inlet to outlet. Rotates in either direction. Interchangeable pistons and cartridge. Optional port specifications. SAE standard mountings and shafts.

Specifications: 90 hp. Model PF 6033 operates at 1800 rpm, delivers



22 gpm at 6000 psi. Model PF 3046 delivers 29.5 gpm at 3000 psi, 1800 rpm. Speeds to 2400 rpm, higher with supercharging. 10⅝" dia, 14¾" length. Weighs 230 lb.
Dynex, Inc., Pewaukee, Wisc.

Circle **304** on Time-Saver Card

HOSE FITTING KITS

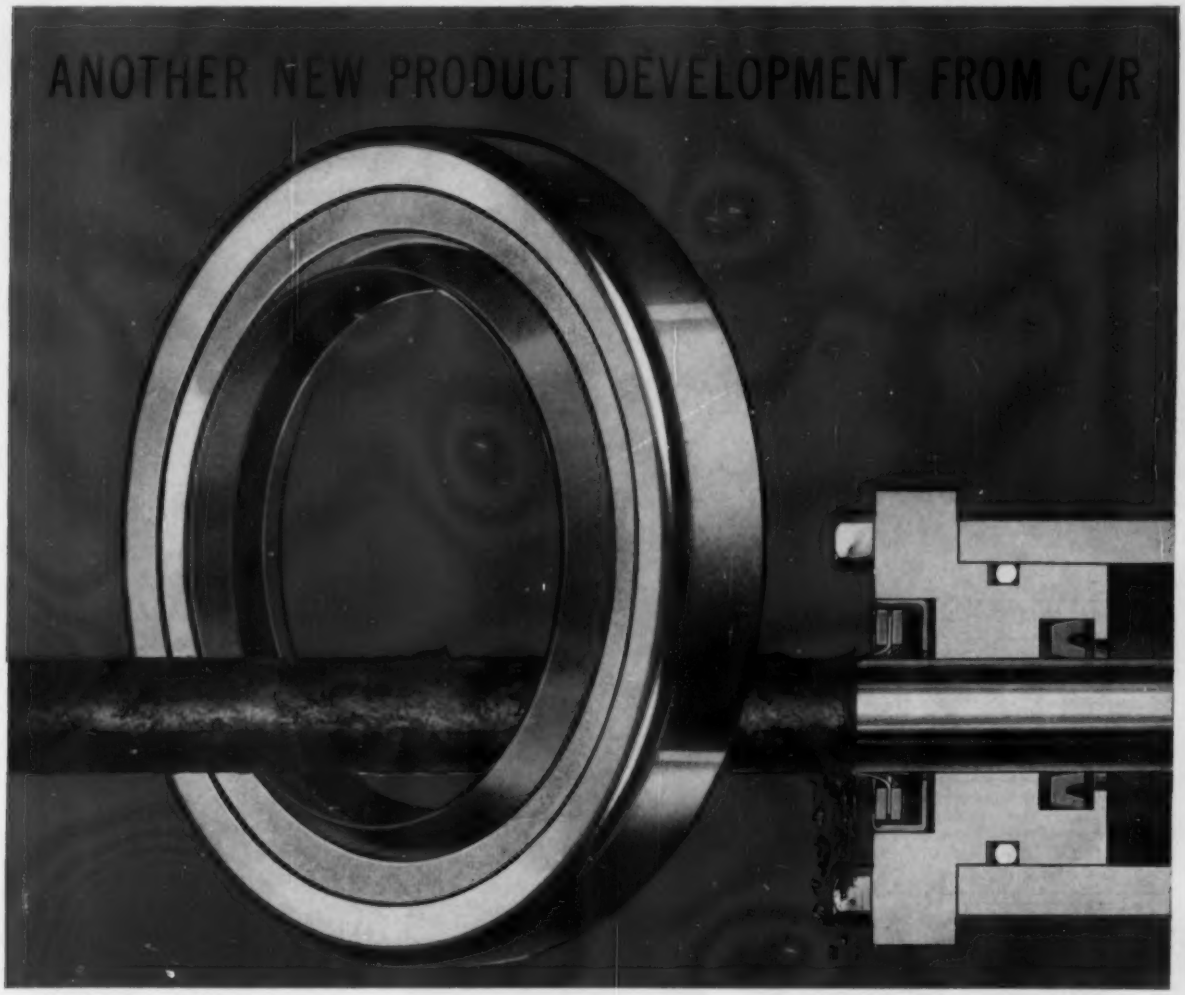
One-piece, socketless, brass fittings are reuseable. To assemble, push hose over fitting's barbed stem. Fitting can't pull out. In all standard connecting ends. Assemblies are for air, oil, or water.

Specifications: For pressures to 250 psi. Cotton or rubber-covered hose in ¼" or ⅜" ID.

Designation: Push-lok fittings—*Parker Fittings & Hose Div., Parker-Hannifin Corp., Cleveland.*

Circle **305** on Time-Saver Card

Continued on page 52



New Wiper-Scraper Seal for Cylinders

Scrapes off ice, mud, tar – wipes off water, dust, other contaminants

Now, you can effectively exclude dirt and other contaminants from hydraulic cylinders under the most severe field conditions. One compact unit, the C/R SC Wiper-Scraper Seal does the job. Formerly, a separate rod scraper had to be installed in front of the ordinary wiper seal. The special machining necessary, plus the scraper ring, and retaining ring made this an expensive installation.

Chicago Rawhide's SC Wiper-Scraper Seal combines a spring brass scraper and synthetic rubber wiping member in one steel shell. The I.D. of the scraper is slightly under shaft size to provide a snug fit that will remove tar or frozen mud, but it has sufficient play within the shell to tolerate any off-center conditions of the rod such as caused by bearing "bore-slop." The cost is much lower than any other combination of scraper and wiper. "Design-in" cost is low, assembly simple. Most important is the performance contribution to the cylinder. The additional value of longer packing life and increased operating dependability with the SC Wiper-Scraper Seal will far outweigh the nominal cost.

For complete information, specifications and standard sizes, write for your copy of C/R's new Bulletin SC-100

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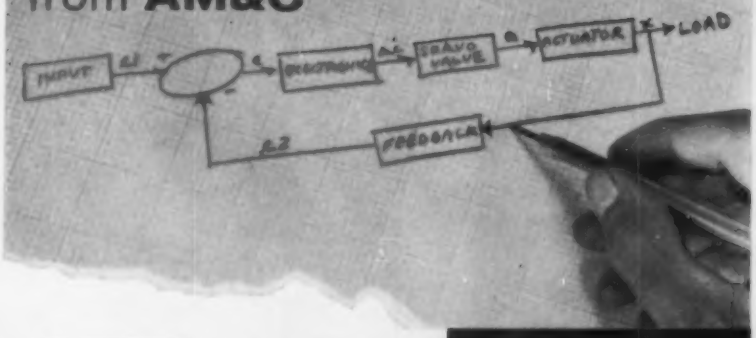
Offices in 55 principal cities. See your telephone book.
In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario
Export Sales: Geon International Corp., Great Neck, New York
C/R Products: C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears.

close the loop . . with ELECTRO-HYDRAULIC SERVO COMPONENTS . . from AM&C



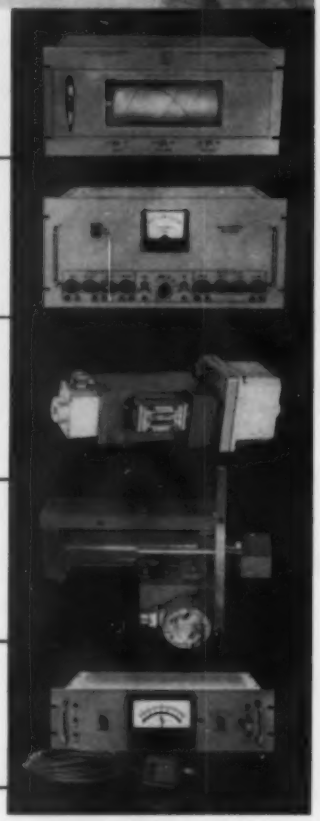
INPUT → *Model 750 Analog Programmer* — Generates a voltage corresponding to an arbitrary function drawn on graph paper: ramp, sine, square and triangular function generators also available.

ELECTRONICS → *Model 601 Servo Amplifier* — Provides summing, amplification and feedback circuitry for driving any electro-hydraulic servo valve. Other standard and special AC or DC amplifiers and demodulators also available.

SERVO VALVE → *Model 244 Electro-Hydraulic Servo Valve* — 0-50 gpm, 3000 psi valve designed for rugged, industrial use. Incorporates powerful, long-life *Model 104 Torque Motor*. Other servo valves available from 0-1 to 0-400 gpm and to 5000 psi system pressure.

ACTUATOR → *Model 500 Hydraulic Actuator* — Completely instrumented. Can incorporate servo valve manifold, filters, solenoids, overload protection, AC or DC feedback devices. Other linear or rotary hydraulic actuators can also be supplied.

FEEDBACK ← *Model 690 Dynamic Position Meter* — Provides feedback voltage and readout as a function of load position. Other feedback units available for sensing pressure, flow, force, velocity, attitude and other parameters.



AM & C can provide *all* of the elements for successful servo control — from the engineering and production of unique electronic, electro-hydraulic and electro-mechanical components to complete integrated system "packages" to do a specific job. If your problem involves instrumentation or automatic control of position, speed, pressure, flow, or force, our engineers can assist you. Telephone or write:

AMC AND

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Subsidiary of CompuDyne Corporation
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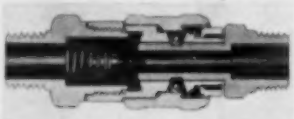
Circle **12** on Time-Saver Card

NEW PRODUCTS

QUICK CONNECT COUPLING

Socket, plug, and internal parts are 316 stainless steel. One-hand operation. No turning or twisting. Buna N seals. Integral shut-off valve in socket stops flow when



lines are disconnected. 360-deg. swivel action permits easy handling, prevents hose from twisting or kinking.

Specifications: For working pressures to 7500 psi connected. Male and female end connections. ⅜" and ¼" NPT.

Designation: Series AS—*Perfecting Service Co., Charlotte, N. C.*

Circle **306** on Time-Saver Card

REMOTE ACTUATOR FOR LIMIT SWITCH

Requires no air valve or air switch. Air is supplied to the actuator at 40-80 psi through an inlet orifice.

It escapes through a bleeder orifice. Closing bleeder orifice builds up pressure in an air cylinder which operates limit switch.

Designation: Part No. 2-1-1000—*R. B. Denison Mfg. Co., Bedford, Ohio*

Circle **307** on Time-Saver Card

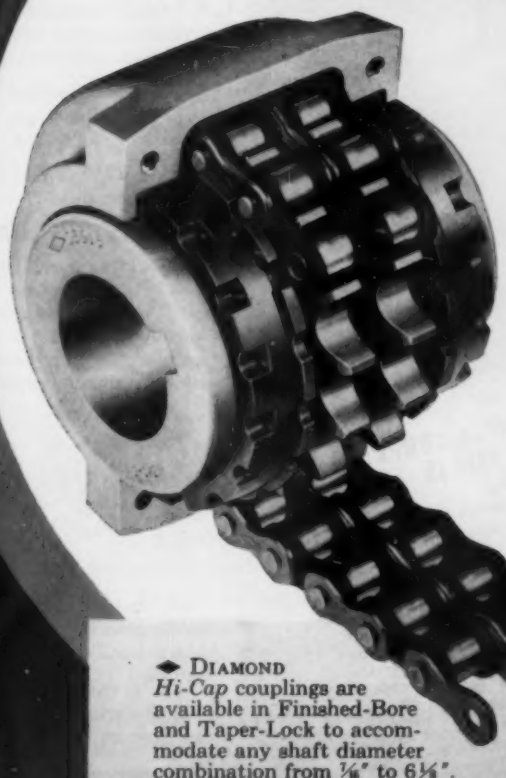
PRESSURE SWITCHES

For pilot duty. One NO and one NC contact. Orifice prevents operation by minor pressure surges. Optional surge reducer and range-adjustment sealing cap. Optional neon light

Continued on page 54

NOW...select
flexible couplings by SHAFT SIZES

new
shaft-rated
DIAMOND *hi-Cap** ™



COUPLINGS
give you
- **lower cost**
- **bearing and shaft protection**
- **quick, easy selection and installation**

**Hi-Cap* means HIGH CAPACITY
All working parts are heat treated steel, and hardened to provide greater resistance to wear, longer service life.

DIAMOND *Hi-Cap* couplings are available in Finished-Bore and Taper-Lock to accommodate any shaft diameter combination from ¼" to 6½". New *Hi-Cap* Bulletin No. 1060-C gives construction details, specifications and prices. WRITE TODAY!

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For full technical data—including a list of incompatible materials—write today for Bulletin No. 56708-1. Linear, Inc., State Road and Levick Street, Philadelphia 35, Pa.
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LINEAR
LINEAR Inc. STATE ROAD & LEVICK ST., PHILA. 35, PA.
Circle **97** on Time-Saver Card

NEW PRODUCTS

tells when pressure is on. Trip indicator behind window shows when switch contacts trip. Calibrated range scale in cover. Bellows type in six pressure ranges. Operates from air, oil, or water pressure. Setting, shown in window, can be adjusted externally with screwdriver. Optional range-adjustment knob. Piston type, for high pressure has range-locking nut. Cylinder wall has oil-leakage outlet on low-pressure side of steel piston. Outlet is tapped for return line to reservoir. Optional seal ring prevents oil leakage past piston.

Specifications: 15-amp rating on 110 vac, 5 amp on 600 vac. Bellows type for pressure to 300 psi; piston type, for 135-3000 psi.

Designation: Bellows type is CR-127 B; piston type, CR127 A.—*General Electric Co., Schenectady*

Circle **308** on Time-Saver Card

POSITIONING AIR VALVE

Inches air-actuated device to any position, and holds. 3-position, 4-way. Solenoid-operated. Three moving parts—spool and positive-centering, spring-loaded sleeves. Built-in manual operators. Valve

body can be removed without disturbing wiring. Connection is made automatically when body is reassembled.

Specifications: ¾" ports. For pressures from vacuum to 150 psi.

Designation: Model 1063, closed center. Model 1073, open center.—*Mechanical Air Controls, Inc., Detroit*

Circle **309** on Time-Saver Card

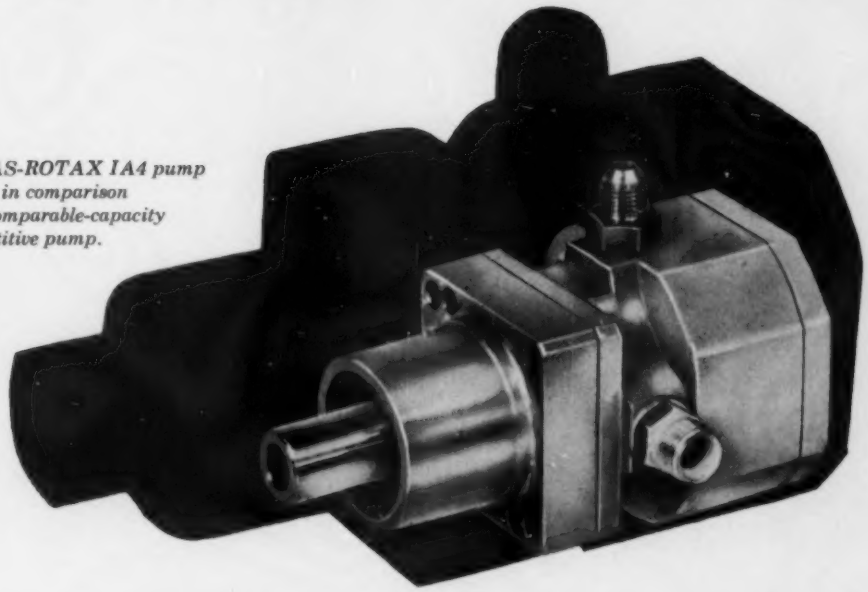
For more NEW PRODUCT reviews turn to page 138

new LUCAS-ROTAX *industrial*

HYDRAULIC PUMPS AND MOTORS

offer the most advanced compact design

LUCAS-ROTAX IA4 pump shown in comparison with comparable-capacity competitive pump.



If you are interested in industrial hydraulic pumps or motors in the 1.5 to 108 g.p.m. range at pressures to 5000 p.s.i., you'll find more good design features in Lucas-Rotax pumps and motors than in any other quality line.

Lucas-Rotax industrial hydraulic pumps and motors are smaller and lighter than conventional units with low noise level in spite of high operating speeds. They offer fast response rate in pressure compensation and the low and medium capacity units can be operated from 2-pole motors to reduce the cost of the prime mover.

Pumps are available as variable volume, variable volume pressure compensated, overcentre cam (reversible) or fixed volume. Motors can be supplied in variable or fixed volume. Both pumps and motors deliver high performance with minimum maintenance. Available in quantity from domestic stock—call or write for technical data.

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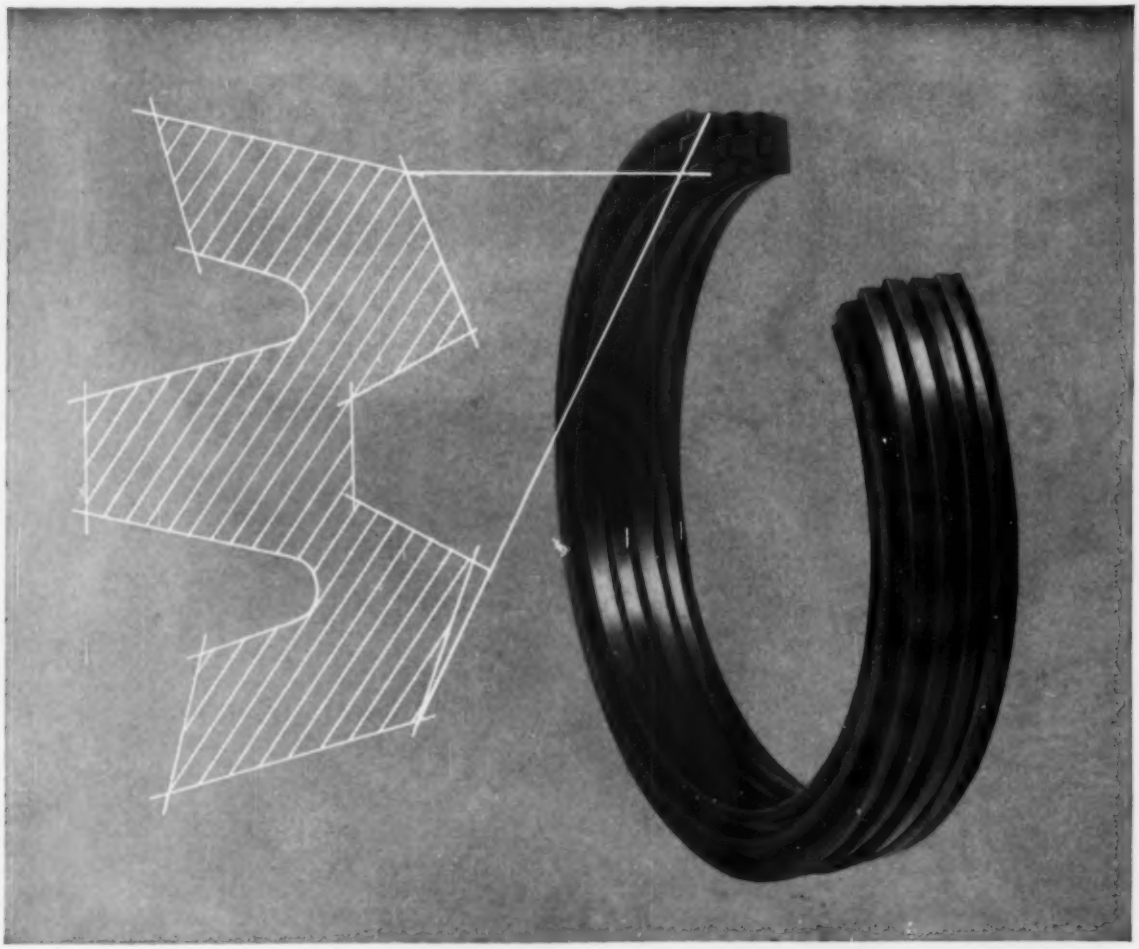


Smaller stuffing boxes made possible with J-M UNEEPAC®

THIS UNIQUE CROSS-SECTION SHOWS WHY UNEEPAC AFFORDS FULLY AUTOMATIC SEALING IN LIMITED SPACE

Because Uneepac offers compact design and greater efficiency...smaller stuffing boxes and fewer rings are required to seal against the most rugged conditions!

These fully automatic, self-centering and self-adjusting packings are pressure-actuated. They are easy to assemble... are quickly installed... fit accurately... reduce friction... give exceptional service life in rod and piston applications.

Skillfully compounded in whatever materials best meet your requirements, J-M moulded packings are engineered with the workmanlike care and precision for which Johns-Manville is known throughout industry. They are specifically designed to give you top performance and optimum economy for every packings dollar you spend.

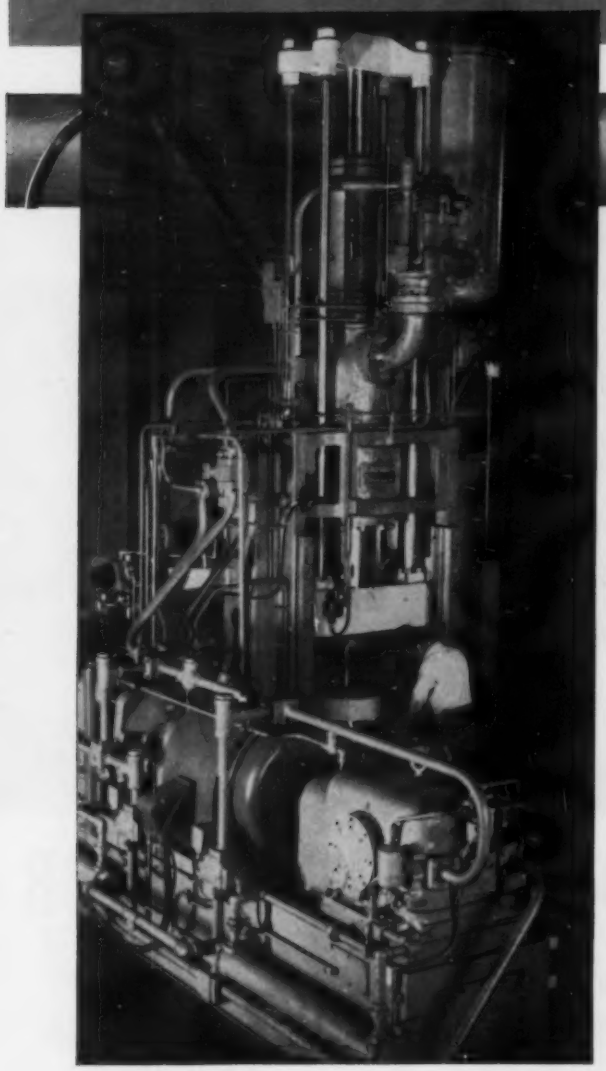
There is a broad selection of J-M moulded packings specifically engineered for hydraulic and pneumatic applications. A complete range of all standard sizes, styles and materials is available for immediate shipment. Or J-M will custom-make and design the exact packing that will give you the best, most economical service.

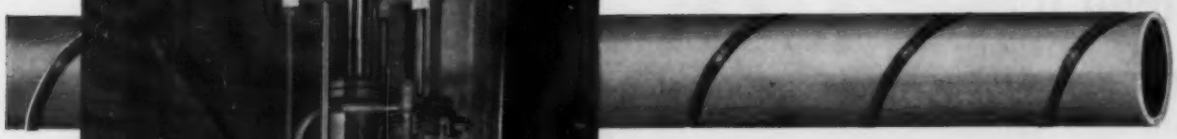
You'll find complete information in free booklets PK-126 A and PK-148 A, which present all J-M moulded packings materials and designs, with specific recommendations for most applications and service conditions. See your J-M Distributor. Or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

REPUBLIC ELECTRUNITE HYDRAULIC FLUID LINE TUBING

offers quality you can identify





Customers with critical tubing requirements wanted to be sure of getting Republic quality. Republic ELECTRUNITE® Hydraulic Fluid Line Tubing with blue spiral marking from end-to-end was the answer. And, only Republic offers it.

Republic ELECTRUNITE Hydraulic Fluid Line Tubing is produced by the world's leading specialty tube manufacturer. Because the tube is formed from highest quality flat rolled open hearth steel, both the inside and outside surfaces can be checked for defects.

ELECTRUNITE's uniform walls and concentricity, coupled with uniformly high ductility, assure better bending and flaring characteristics. And, ELECTRUNITE is available in all sizes shown in JIC Standards Book, in wider range of sizes produced to Specification HL-1, which meets all test requirements of the JIC Standard.

It will pay you to get all the facts on Republic ELECTRUNITE Hydraulic Fluid Line Tubing. Discover how it can substantially reduce maintenance costs in complicated installations. Call your Republic representative, or write direct today. Use coupon below.

This 500-ton hydraulically operated press built by Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa., and featuring Republic ELECTRUNITE Hydraulic Fluid Line Tubing, is used by a leading research center for deep drawing, extruding, or planishing metals.

REPUBLIC STEEL
STEEL AND TUBES DIVISION

REPUBLIC STEEL

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Please send additional Republic ELECTRUNITE Hydraulic Fluid Line Tubing information and specifications.

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Firm _____

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FEATURES

1
Knife edge orifice positively assures consistently uniform low flow; and minimizes change of flow when change of fluid temperature occurs.

2
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3
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5
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6
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4-Way Hydraulic Valves

Small, spool valves provide 11 flow patterns. Spring-centered, spring-offset, and detent models. Flow to 3 gpm. For pressure to 2000 psi. Two data bulletins show flow-pressure characteristics, dimensions, JIC symbols, flow patterns, weight, material, and porting. *Sarasota Precision Products, Inc., Sarasota, Fla.*

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PUMPS & FLUID MOTORS

Bulletin 100-P7 describes Series 15 Model H. constant-displacement units. For pressures to 2000 psi, speeds to 2000 rpm. Pump capacity from 2 to 24 gpm. Motor output from 1 to 20 hp. Pressure-pocketed thrust plates—a dynamic seal prevents oil flow from the high-pressure side to the low-pressure side of thrust plate. All surfaces of matched, helical gears are ground and polished. Oversize anti-friction bearings. Two heavy-duty inboard bearings for each gear are on integral gear journals. Outboard bearing in each pump or motor overcomes shaft radial and thrust loads. Bulletin has photos and charts of options on end covers, gear housings, and drive shafts. Performance charts. Bulletin 100-P6 describes Series 36 Model H units. Same general features. Pump capacity from 10 to 65 gpm. Motor output from 10 to 80 hp. *Commercial Shearing & Stamping Co., Youngstown, Ohio.*

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PLASTIC PARTS

Bulletin has photos and complete specifications for Teflon TFE in sheets, cementable sheets and tapes, extruded rods, molded bars, and cylinders, and filled and fusion-welded products; for Chemiseal Nylon in rods, slabs, films, sheets, tubes, and pressure tubes; for CTFE in discs, sheets, and rods; and for Delrin and Teflon FEP in sheets, rods, and tubes. Bulletin AD-177 has chart of comparative mechanical and electrical characteristics of compounds. 16 pp. *Garlock, Inc., Palmyra, N. Y.*

Circle **403** on Time-Saver Card

CYLINDERS, DRILL UNITS & VALVES

Catalog has data, specifications, and schematics on complete line of air and oil products. Introduces Series B interchangeable cylinder. 24 pp. *Alkon Products Corp., Hawthorn, N. J.*

Circle **404** on Time-Saver Card

ROTARY ACTUATORS

Single-vane model rotates 280 deg. Double-vane models have twice the power, rotate only 100 deg. Actuators produce torques from 100 to 430,000 in-lb on standard units. Heavy-duty line is for 2000 psi. Heads are machined from cold-drawn steel. Bodies are of mechanical, seamless steel tubing. Shafts are of stress-relieved steel. Internal surfaces are hard-chrome plated. Stators are keyed to body. Vanes are keyed and brazed to shaft. Ball bearings on standard models. Roller bearings on heavy-duty models. All seals replace easily. Seals are backed by Teflon. Bulletin shows dimensions and ratings, application drawings, and mounting data. *Roto-Tork Mfg. Co., St. Clair Shores, Mich.*

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QUICK-CONNECT COUPLINGS

For air and oil. Series 1A Breco Pushomatic couplings for one-hand operation. Maximum working pressure is 5000 psi. Flow 14 cfm or 2.5 gpm at 100 psi. Series 2A for 6000 psi. Pressure drop is 4 psi at 15 cfm and 100 psi. Series 4A for 4000 psi. Pressure drop is ½ psi at 20 cfm, 100 psi. Ball bearings of double-shut-off couplings allow hose to swivel when being moved. Steel model flows 8.5 gpm at 100 psi. For working pressure to 8000 psi. Bulletin 1475 also shows straight-through couplings, reusable fittings, barbed hose fittings, adaptors, hose and hose assemblies, ferrules, ferrule crimping die, and rotary air seal. Photos, descriptions, and specifications. 16 pp. *Perfecting Service Co., Charlotte, N. C.*

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ALL-STAINLESS STEEL FILTER & ELEMENTS

Tables list filter areas from ½ to 4 sq ft, pipe sizes from ¼" to 1" NPT, and maximum overall heights from 4¾" to 16½". 98% removal ratings from 165 down to 5 microns. Some elements withstand 10,000 psi differential pressure. Release M-213A. *Micro Metallic Div., Pall Corp., Glen Cove, N. Y.*

Circle **407** on Time-Saver Card

Continued on page 62

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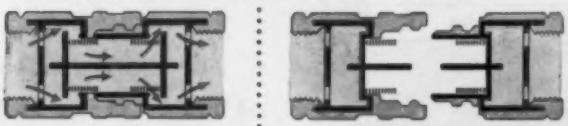

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USEFUL LITERATURE

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Photos, descriptions, and specifications of tube cutters, tube constrictor, sawing vises, flaring tools and double flaring tools (37 and 45 deg), reaming tools, tube benders (lever-type, combination, gear-type, spring, ratchet handle adaptor), tubing tool kits, swaging tools, sizing tools, refacing tools (37 and 45 deg), pinch-off tools, test plugs, test caps, and tool parts kit. Parts list. Catalog No. 3121 has 32 pp. *Imperial Brass Mfg. Co., Chicago.*

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POWER UNITS, PUMPS, MOTORS & VALVES

For 5000 psi. General bulletin outlines specifications of horizontal and vertical pumping units, axial-piston fluid motors, vane pump/motors, axial-piston pumps, vane pumps, and valves for surge-damping, check, flow-control, directional control, remote-control, and pilot and electrohydraulic pressure-control. Refers to detailed bulletins. Bulletin 146-F. *Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio.*

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SPLIT-BODY CONTROL VALVES

S type has actuators perpendicular to pipeline. Actuators of Y type are at 45 deg. from line. Catalog has specifications, data, and dimensions of valve bodies and actuators. Actuators include positioning-piston, on-off-piston, electrohydraulic, manual, electric gear-driven, and pneumatic. Tables of size, rating, end connections, valve action, materials, CV factor, effective area, and maximum pressure drop. *General Controls Co., Warwick, R. I.*

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For more reviews of FREE LITERATURE turn to page 150

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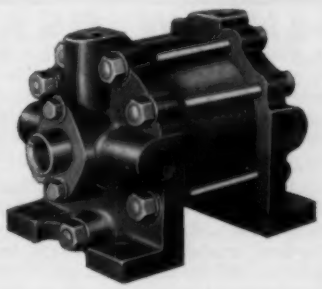

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Announcing

THE 1960 AWARD WINNERS

Each year the HYDRAULICS & PNEUMATICS Prize Paper Contest, which is open to all readers, produces papers describing many phases of hydraulic and pneumatic design, application, and maintenance. This year's entries represent advanced ideas in component design, machine system application, and theoretical development. These were judged by three outstanding authorities in the fluid power field: **J. A. Draxler,** Chief Engineer, Elwell-Parker Electric Co.; **W. E. Mayhew,** Staff Engineer, Republic Aviation Corp.; **R. K. Sedgwick,** Assistant Chief Engineer, Servo Machine Tool Div., Kearney & Trecker Corp. Each entry was evaluated on the basis of practicality, economics, orginality, and presentation.

On the following pages the award winners are presented together with the three top prize papers. All papers which have received an award or honorable mention will be published in future issues.

First
AWARD PRIZE
$500

Werner Holzbock

PRINCIPLES OF SERVOVALVES

As author of two books on instruments and controls, Holzbock is well versed in the design and operation of servovalves. He received his degree in mechanical engineering from Columbia University, and has studied in Germany and South America. He was manager of instrumentation and control systems at Sanders Associates, and chief engineer for GPE Controls. He is now a consulting engineer for control systems and instruments.

Holzbock's two books are titled "Instruments for Measurement and Control," and "Automatic Control: Principles and Practice". He has also written many technical articles for magazines in this country and abroad.

Second
AWARD PRIZE
$300

Gil Riske

USING FLOW COEFFICIENTS TO DESIGN PNEUMATIC SYSTEMS

The design and application of pneumatic devices has occupied most of Gil Riske's engineering career since receiving his BSME at the University of Illinois. His first work after leaving the university was in the fluid power field. Since that time he has published many articles on pneumatics and related subjects.

Riske has done considerable research on flow phenomena. He has recently been studying capacity coefficient as they pertain to air controls. As Senior Engineer at Hannifin he has been active in applying engineering economics to pneumatic circuitry.

Third
AWARD PRIZE
$200

J. R. Crissey

DESIGNING DAMPERS TO STABILIZE A JET FIGHTER

Prior to joining Chance Vought, J. R. Crissey served as navigator on B-24 bombers with the Air Force. He studied mechanical engineering at the University of Pittsburgh. While at Chance Vought he worked on the design of the hydraulic and pneumatic systems for the F7U twin-jet fighter, the F8U Crusader, and the Regulus I & II Navy guided missiles. Crissey is design project leader on advanced weapons proposals and at present is project engineer on an electro-mechanical project for the Electronics Division of Chance Vought.

Fourth—Seventh Prizes

$100 EACH

Frank J. Acton, Machine Design Specialist, Design Consultants, Park Forest, Ill. "Three Position Hydraulic Cylinder."

Arthur M. Salek, General Sales Manager, Martonair Ltd., Richmond, England. "A Universal Method of Solving Fluid Power Sequence Circuits."

Dieter E. A. Tannenberg, Test Engineering Supervisor, Flexonics Research Laboratories, Elgin, Ill. "Significance of Hydraulic Hammer in High Pressure Circuits."

Fred J. Weir, Design Engineer, The Hufford Corp., El Segundo, Calif. "Rocket Engine Transport and Erecting Vehicle."

Honorable Mention

Carl G. Auld, Fluid Systems Components Engineer, The Martin Co., Baltimore, Md. "A Reliability Program for Fluid Contamination Control in Hydraulic Systems."

William H. Baier, Senior Research Engineer, Armour Research Foundation, Chicago, Ill. "Dynamics of Hydraulic Cylinders."

Alex Bloch, Manager and **A. Konstantin,** Senior Development Engineer, Military Products Div., Singer Mfg. Co., Bridgeport, Conn. "Design Considerations for Moon Base Hydraulic Systems."

Paul L. Brady, Pneumatic Group Engineer, Convair, A Division of General Dynamics Corp. "Pneumatic Actuating Cylinder Control."

Kieth Brownfield, Supervisor of Product Engineering, The Warner & Swasey Co., New Philadelphia, Ohio. "Hydraulic Wagon-Mounted Gradall."

J. F. Buddington, Supervisor, Quality Engineering, Chance Vought Aircraft, Electronics Div., Dallas, Texas. "Automated Hydraulic Pump Test Stand."

Robert A. Cox, Design Engineer, Convair Astronautics, A division of General Dynamics Corp., San Diego, Calif. "Hydraulic Actuation of the Convair Jetliner Main Landing Gear."

Nissim Franko, Engineer, Industrial Design & Development, Tel-Aviv, Israel. "Dimensioning the Port Plate of an Axial Piston Pump."

A. F. Gagne, General Manager, A. F. Gagne Associates, Binghamton, N. Y. "New Hi-Flex Dust Boot Fits Existing Cylinders."

C. W. Galloway, Research Engineer, Hydro Mechanical Group, Douglas Aircraft Co., Inc., Santa Monica, Calif. "New Hydraulic Seals Used in Douglas DC-8 Jetliner."

Howard L. Harrison, Assistant Professor, Department of Mechanical Engineering, University of Wisconsin, Madison, Wis. "Null-Position Flow Forces in an ideal Three-Way Hydraulic Servo Valve."

George R. Keller, Chief, Sales Engineering, Autonetics, A Division of North American Aviation Inc. "The Role of Hydraulics In Space."

George F. Meagher, Development Engineer, Aerojet General Corp., Sacramento, Calif. "Affects of Contamination on Servo Valves."

Henry L. Meyer & Fred R. Wilhelm, Engineers, Cleveland Trencher Co., Cleveland, Ohio. "Positive Hydraulic Positioning of a Special 4-Bar Linkage."

George E. Miller, Head, Mechanical Unit Development Group, Tactical Support Equipment Section, Guided Missile Laboratories, Hughes Aircraft Co., Culver City, Calif. "Hydraulic & Pneumatic Ground Support Equipment for the Super Falcon Missile."

D. S. Morcock & W. M. Law, Design Engineers, Lockheed Aircraft Corp., Marietta, Ga. "Hydraulic Loading and Pressurization Systems for C-130 Hydrostatic Pressure Fatigue Test."

H. C. Mouwen, Manager, Research & Development, Purolator Products, Inc., Rahway, N. J. "Testing Pore Size in Porous Metal Filtration Media."

Egon E. Muehlner, Chief Project Engineer, Convair Instruments, A Division of General Dynamics Corp., San Diego, Calif. "Measuring Hydraulic Leakage."

E. F. Olsen, Design Engineer, Brantford Coach and Body Ltd., Brantford, Canada. "Valves in Piston Control Stroke in Double-Acting Cylinder."

R. K. Pealstrom, Industrial Products Div., Westinghouse Air Brake Co., Wilmerding, Pa. "Pneumatic Positioners Simplify Marine Engine Control."

Lester J. Reitman, Surface Armament Division, Sperry Gyroscope Co., Division of Sperry Rand Corp., Great Neck, L. I., New York. "High-Temperature Electrohydraulic Servo Valve."

Albert A. Schmitz, Tool Designer, J. I. Case Co., Racine, Wis. "Hydraulic Compression Molding Machine."

E. G. Spencer & G. F. Tellier, Rocketdyne, A Division of North American Aviation, Inc., Canoga Park, Calif. "An IRBM Engine Control System."

Oscar L. Wadkins, Director of Engineering, Hydra-Electric, Inc., Burbank, Calif. "Hydraulics Used for In-Flight Flutter Testing."

FIRST PRIZE

WERNER G. HOLZBOCK
Consulting Engineer, Nashua, New Hampshire

Principles of servovalves—

What are the important factors you should look for in servovalve performance. Just how important is each? Here is a thorough discussion of servovalve performance and how it is affected by design. Part II of this article, which will appear next month, will analyze basic servovalves designed by the author.

AS DESIGNERS work more with electrohydraulic servo systems, they must get used to thinking in terms of servo performance. For servovalves, which are the transfer point between electronic and hydraulic controls systems, performance is measured by the criteria discussed in this article.

DIRT SENSITIVITY

Servovalve reliability depends on effects of unavoidable dirt particles. On aircraft applications, filtering to 10 microns and even 2 microns is common. This is extremely fine, especially when you consider that a human hair is about 60 microns thick. It is not practical to use a large industrial filter which eliminates *all* particles bigger than 10 microns. Hydraulic oil used in industry can not be kept clinically clean. Fine filtering in systems subject to contamination requires frequent maintenance to change filters. A better design is to use servovalves with large flow passages having diameters of 10 microns or more.

RESOLUTION SENSITIVITY

This is the smallest change of input signal that can change hydraulic output flow from the valve. It is sometimes argued that resolution sensitivity does *not* mean reversing the input signal to determine the magnitude. In this case, resolution sensitivity is caused only by static friction.

Deadband is generally defined as the input range which does not produce output response. This means reversing the signal. Deadband in this case is equal to resolution sensitivity plus lost motion like backlash and overlap. All this is merely a matter of definition. As understood here, resolution sensitivity is the same as deadband.

Whatever prevents a valve from responding to even the smallest change of input signal, reduces its resolution sensitivity. For example, if maximum input signal is 100 milliwats, force exerted by the signal system may be 6 oz. A resolution sensitivity of 0.1% would then mean that the device responds to a change in force of 0.006 oz., or about 0.0004 lb.

Friction limits resolution sensitivity more than anything else in servovalves because of extremely small positioning forces. As becomes obvious from the preceding example, even ball bearing friction is not negligible.

DYNAMIC RESPONSE

The ability of a servovalve to follow changes in the input signal is called dynamic response. Whether *high* dynamic response is needed depends on the application; there is a trend toward higher dynamic response requirements. One of the main elements affecting dynamic response is load inertia. Load mechanisms should be as light as possible. If output motion is rotary, weight should be concentrated as close to the center of rotation as possible.

LINEARITY

This is a measure of the ratio between input and output. If a system requires equal increments of output for equal increments of input, linearity is important. But is this true in a closed loop, proportioned control system?

The servovalve is part of a control system. It may direct flow to a cylinder which positions a control valve. With maximum signal to the servovalve, the control valve opens wide. With minimum signal, it closes.

Part 1

Suppose, a 100-inch liquid level in a tank is being controlled. At 50-inch level, the process control valve is wide open to admit more liquid. At 150-inches, the valve is closed. Flow is proportional to the level. This kind of control cannot maintain the level at 100-inches when the tank's outgoing flow changes. The outgoing flow increases and the level drops to, say 80 inches in spite of the control system. This is called *offset*.

If the control is so vague, it doesn't matter much if—because of gross non-linearities—the level is 75 or 85 inches. To compensate for offset, reset or integral control action is added. This brings the level back to 100 inches with or without linearity.

Another possibility is increase of gain. In fact, this is always the first thing to do, but it works only up to a point. After this, the system gets unstable. Suppose the gain can be increased to the point where at 98 inches the control valve is fully open and at 102 inches it is fully closed. Now with the same increase of outflow, the level drops only to 99.2 inches instead of 80 inches. The same gross non-linearities may make this 99 or 99.4 inches. Is it conceivable that a drop to 99.2 is permissible but not to 99.0 or 99.4? Again, the non-linearity is no factor.

Furthermore, final control elements and the load being actuated usually have many non-linearities, so that striving for linearity in the servovalve is not realistic. Excessive non-linearity, however, of more than about 10% is equivalent to a change in system gain. Gain in the electronic controller may then have to be lowered to maintain stability for certain servovalve positions. In other positions this lower gain may result in a sluggish system. This is the only case where linearity is important, but it will seldom require better than 10%.

HYSTERESIS

This is the changing relation between input and output, depending on whether the input signal is increasing or decreasing. It is definitely *not* resolution sensitivity. In electrohydraulic servovalves, practically

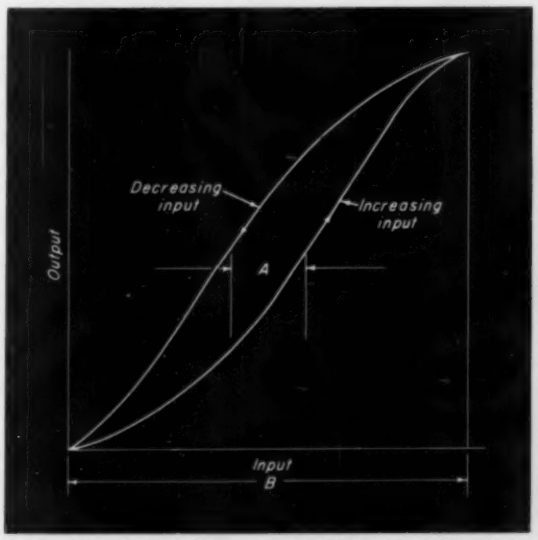
"But I cannot tolerate a hysteresis of 3%. The system wouldn't have the required dynamic response."

Thus the project engineer of a large company rejected a servovalve that had been specially designed for his very stringent flow and internal leakage requirements. The servovalve supplier had met these requirements, but hysteresis had crept up from the usual 2% to an unexpected 3%. He had tried everything to decrease it, but without success. His chief engineer and his customer's project engineer faced an apparent impasse.

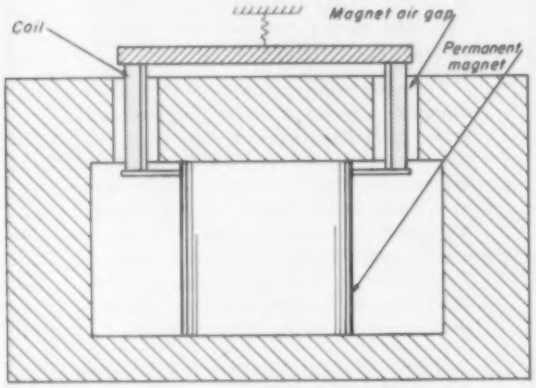
When the project engineer said that hysteresis would affect dynamic response, something dawned on the chief engineer. "What do you mean, *dynamic response?*" he questioned, "this is *hysteresis.* Aren't you thinking of *resolution sensitivity?* Remember, the valve's resolution sensitivity is 0.2."

Ten minutes later, both engineers realized that all the talking and all the wasted effort was caused by a semantic misunderstanding. The servovalve not only met but exceeded the specifications.

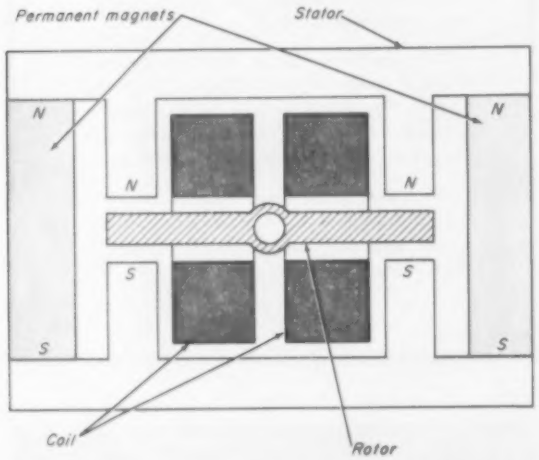
Do other misunderstandings, and biased opinions prevent us from a rational approach to designing electrohydraulic valves?



HYSTERESIS is the maximum possible difference of input signal for the same output signal. It is generally expressed in percent of input signal range as 100A/B.



MOVING COIL servovalve actuator has coil moving in air gap of permanent magnet. Force is proportional to current through the coil.



TORQUE MOTOR servovalve actuator has magnetized rotor rotating in permanent magnetic field. Current through coils magnetizes rotor according to current strength and polarity.

SERVOVALVE ACTUATOR CHARACTERISTICS

	VOLUME cu. in.	OUTPUT FORCE in. lb. (W = milliwatt)	STROKE ± in.	OUTPUT FORCE × STROKE × 10^3 (approx.)
Torque Motor I	1	.074 $\sqrt{W}$	.006	4 $\sqrt{W}$
II	2.2	.095 $\sqrt{W}$	.007	7 $\sqrt{W}$
III	3.3	.146 $\sqrt{W}$	.008	12 $\sqrt{W}$
IV	8	.162 $\sqrt{W}$	.015	24 $\sqrt{W}$
V	30	.240 $\sqrt{W}$	.020	48 $\sqrt{W}$
Moving Coil	30	.030 $\sqrt{W}$	.060	18 $\sqrt{W}$

all hysteresis results from the magnetic circuits of torque motors and not mechanical effects. Hysteresis is expressed as a percentage of the maximum input signal range. For example, a servovalve may have a hysteresis of 2% of the signal range. This is the hysteresis resulting from increasing and decreasing the input signal through its full range. (This hardly ever happens in an actual application.) If the input signal increases and decreases through 1% of its full range, then hysteresis decreases to approximately 1% of its full range value or 0.02%.

The effect of hysteresis is similar to linearity. In closed loop systems, a hysteresis of 10% or less has practically no effect.

SIGNAL SYSTEMS

The electrical signal applied to an electrohydraulic servovalve must be converted into mechanical motion to actuate the valve. The two devices most frequently used are the moving coil and the torque motor.

The moving coil has the advantage of great simplicity and low cost. However, it is much bulkier than the torque motor and has poorer frequency response.

The table compares characteristics of torque motors and moving coils. Values are approximate, and based partly on estimates.

Moving coils have no hysteresis; torque motors have. But this has little importance. Moving coils have longer strokes. The stroke of ±.060 inches shown in the table is a rather arbitrary value. It is based on experience that a coil can move through such a stroke without noticeable decrease of net force, because it makes use of magnetic field fringing.

Output forces shown in the table are based on torque motors with series-connected windings. This is contrary to usual practice. Normally, a push-pull amplifier is used, and the coils are connected for push-pull operation. This may be an advantage in the amplifier design, but cuts torque motor force output in half.

Comparing output forces in the table, the moving coil is worst. However, because of its longer stroke, the product of force times stroke (which is equivalent to available energy) is in the order of magnitude of torque motors. However, in making use of the long-stroke characteristics of the moving coils, dynamic characteristics suffer severly. This is shown in the following:

A moving coil that develops the force listed in the above table has about 0.12 lb. of copper. Total weight is about 0.15 lb. This corresponds to a mass, m of $0.15/386 = 0.00039$ lb-sec^2/in. If an input power of 3 watts is available to move the coil through its full stroke, at 1.5 watts, the coil is at mid-position. According to the table, the force that produces the maximum displacement of .06 inch is $.03\sqrt{1500} = 1.16$ lb. The required spring rate is $K = 1.16/0.06 = 19.4$ lb/in. This results in a natural frequency of

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = 36 \text{ cps.}$$

The armature of a torque motor, for instance type III in the table, weighs about 0.03 lb. The same input power of 3 watts would move it through a stroke of ±.008 inch. The force that produces this stroke is $.146\sqrt{1500} = 5.65$ lb. The required spring rate is $5.65/.008 = 700$ lb/in., and the resulting natural frequency is

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = 480 \text{ cps.}$$

Torque motors cost about five times as much as moving coils, and in many cases this will be the decisive factor. The result of these considerations is that the torque motor will be used where dynamic response and compactness are the main requirements. Where bulk and dynamic response are acceptable, the much lower cost of the moving coil wins out.

Another point which should be considered here is that practically all commercially available torque motors use torque tubes torsion springs as pivots. This requires rather high spring constants, and consequently comparable high actuating forces. The result is that torque motors require high input power, Present-day, commercially available, industrial electronic controllers have low power outputs. They practically require using a moving coil instead of torque motor. These controllers seem to be limited to low frequency applications unless there is additional amplification.

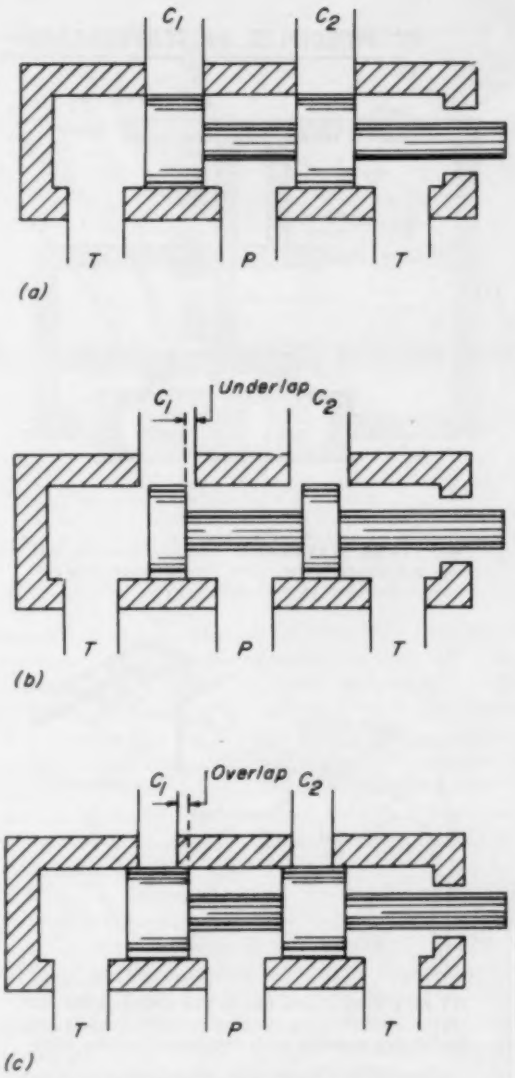
VALVE DESIGNS

A valve converts motion of the signal system into a hydraulic output. Common designs are flapper-nozzle, jet-nozzle, and spool. Combinations of these form 2-stage and 3-stage valves.

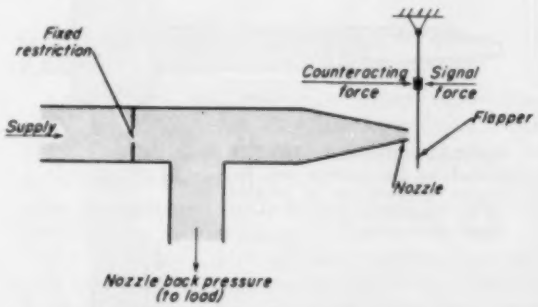
• **Spool**—The second stage of nearly all 2-stage valves is a spool valve. The use of spool valves for the first stage is less common. Valves with small flow capacities have small openings, particularly at small signals, and the tendency for clogging under such conditions becomes a handicap. In selecting a 4-way valve, one has to decide between closed-center design and open-center design which allows internal leakage. Some internal leakage generally has little effect, so that using a closed center spool valve as first stage or single stage has few advantages. Furthermore, a spool valve is more expensive to build than a flapper-nozzle or a jet nozzle.

Spool valves tend to oppose opening. This is caused by flow forces produced by the flow passing through the valve ports. These flow forces can be reduced by shaping the flow passage between spool and sleeve. The smaller the valve flow capacity, the less the flow forces.

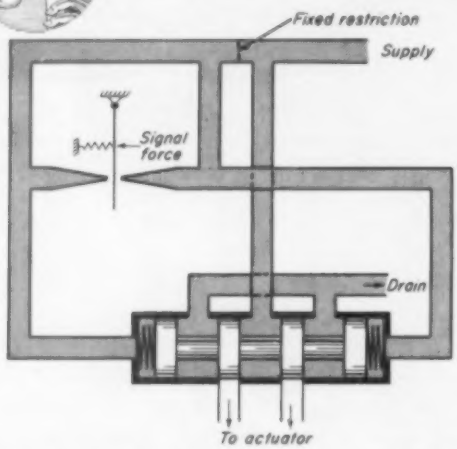
• **Flapper-Nozzle**—The adjustable flow area of a flapper-nozzle is the space between nozzle tip and flapper. Fluid passes through the nozzle, impinges on the flapper, and is deflected at right angles. The nozzle diameter must be kept small to limit hydraulic force against the flapper.



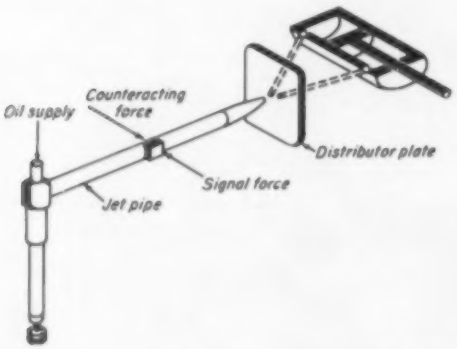
FOUR-WAY SPOOL VALVE DESIGNS show zero lap (a), underlap (b), and overlap (c). Zero lap is near impossible to achieve and maintain. Underlap gives an open-center valve. Overlap produces deadband.



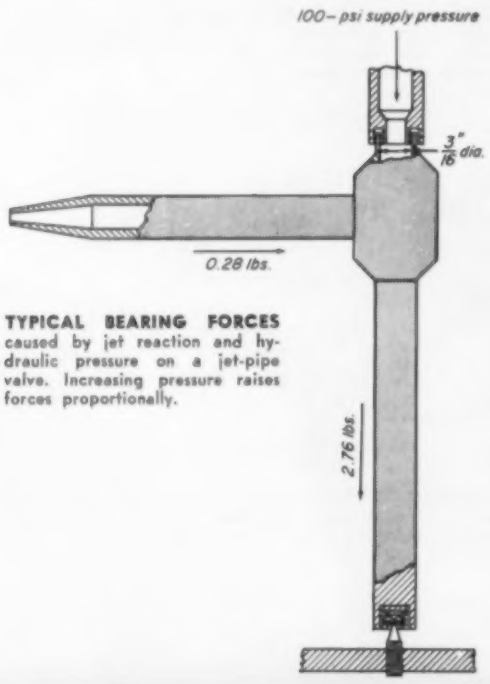
FLAPPER-NOZZLE valve applies varying nozzle backpressure to load (or second stage). Backpressure changes with flapper position as restriction to nozzle flow changes.



TWO-STAGE SERVOVALVE has flapper-nozzle first stage and closed-center, spool second stage. Flapper-nozzle is arranged as push-pull.



JET PIPE valve directs flow to two orifices in the distributor block. Moving the pipe increases pressure and flow at one actuator port, decreases it at the other.



TYPICAL BEARING FORCES caused by jet reaction and hydraulic pressure on a jet-pipe valve. Increasing pressure raises forces proportionally.

The adjustable flow area is determined by multiplying distance between flapper and nozzle times nozzle opening circumference. When the distance between flapper and nozzle is equal to ¼ nozzle diameter, the adjustable flow area has virtually reached its maximum. Moving the flapper farther away from the nozzle has very little effect. The push-pull arrangement requires that the centered flapper be ⅛ the nozzle diameter away from either nozzle. The adjustable flow area, A, for the midposition is then:

$$A = \frac{\pi D^2}{8}$$

where D is nozzle diameter.

For an area of 0.002 sq. in., the diameter would be .0051 inch. The distance between flapper and nozzle would be D/8 or .00064 inch. This is about 1/5 the thickness of a human hair. The contamination problem is obvious. When the flapper moves from its midposition, the situation improves on one nozzle, but gets worse on the other.

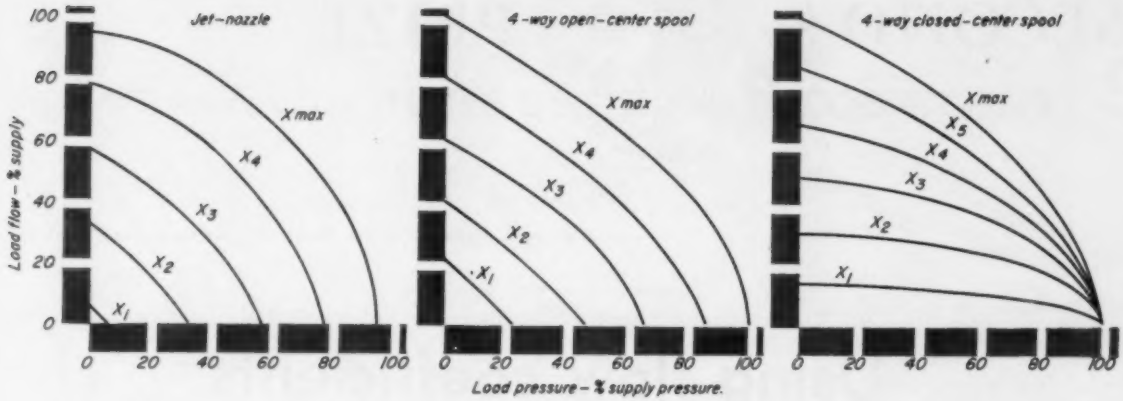
• **Jet-Nozzle**—We can compare the performance of a jet-nozzle with a flapper-nozzle, by determining flow capacity of each for a certain pressure. Assume the area of the flapper-nozzle's *fixed* restriction is the same as its *adjustable* orifice area, with the flapper in midposition. If the value is .002 sq. in., flow through the nozzle is about .35 gpm at 100 psi supply pressure. This is .7 gpm for both nozzles. A jet nozzle would require a diameter of 0.06 inch for the same flow: about 100 times larger. This is equal to the thickness of about 20 human hairs. Furthermore, the jet-nozzle flow passage never diminishes with position changes as the flapper-nozzle does. These are the reasons why the jet-nozzle is so much less susceptible to clogging than any other hydraulic valve.

The jet-nozzle needs a larger displacement than the flapper nozzle. In the above example, the jet nozzle would move a total of ±0.04 inches; the flapper-nozzle would move ±0.00064 inches. The flapper-nozzle's shorter travel could be a design advantage in some cases. In practice, the jet-nozzle's longer travel does not seem to be a disadvantage.

Jet-nozzles convert static pressure into velocity and then reconvert it into static pressure in the receiving orifice. Energy is lost in these conversions. Depending on pressure, flow capacity, and design, pressure loss is generally 5% to 20% of supply pressure. There is no data on flapper-nozzle efficiency, but it can be assumed that there is a comparable loss, since the flapper is not designed to close the nozzle completely. In deciding between single-stage and two-stage valves, energy loss of a single-stage, jet-nozzle valve may make a 2-stage valve more favorable.

Jet pipe design is not too difficult for pressures up to 1000 psi. Above this, it is necessary to provide orifices in series or some other pressure-dropping means.

In most present designs jet-nozzles have the disadvantage of being designed as jet-pipes, because of past experience. Ball bearings are generally used,



PRESSURE-FLOW CHARACTERISTICS of servo valves. Maximum flow does not occur at the same time as maximum pressure across the load. For the 4-way, closed center valve, maximum pressure across the load is possible with even the smallest displacement. x_1, x_2, x_3, etc. represent increasing valve displacements.

and because of extremely low friction required for high resolution sensitivity, they have become an appreciable source of friction. For a supply pressure of 100 psi, the horizontal force component on a conventional jet-pipe is 0.28 lb. This is caused by the jet nozzle opening—the familiar jet repulsion force. Another force of 2.76 lb. acts down on the closed end of the jet pipe. This is caused by hydraulic pressure. If pressure were 1000 psi, instead of 100 psi, the forces would also be increased 10 times.

A recent design eliminated the horizontal force by using two opposed jet-nozzles. However, the large vertical force remained unaffected.

It was shown above that the force to move a device having high resolution sensitivity may be as low as 0.0004 lb. Even the best ball bearings, under a load of several pounds as in the above example, will probably have more friction than that.

Jet-pipes have other limitations. One is that they produce considerable turbulence in the fluid flow. The flow passage is relatively narrow, and the 90-degree bend makes the situation worse. These cause undesirable pressure losses. The other limitation is the inertia of most jet-pipes. This is due to a relatively large mass concentrated at a rather large radius from the pivot. The result is slow dynamic response.

There has not been enough systematic investigation of jet-nozzle sizes, configurations, pressures, air entrainment, and other factors. Knowing more about these would widen their scope considerably.

INTERNAL LEAKAGE

Hydraulic fluid that drains back to the reservoir from the servovalve without doing work is called internal leakage. A closed-center valve has no internal leakage; an open-center valve has internal leakage. While an actuator, controlled by a single-stage, jet-nozzle valve remains in one position, all flow through the servovalve is internal leakage. Full flow passes through a single-stage, jet-nozzle valve at all times, whether flow is needed for doing work or not. Is this a disadvantage? This depends on what would happen if a closed-center valve which has no internal leakage would be used instead. In that case, if the pump would discharge excess flow through a relief valve, little is gained by cutting out internal leakage. The closed-center valve would only put the leakage *outside* the servovalve, into the relief valve.

Where a flapper-nozzle or jet nozzle is the first stage of a servovalve, all flow through the first stage is an energy loss. Suppose the servovalve capacity is 20 gpm, and the first stage capacity is 1 gpm. The loss seems very high, but what does it mean? It is an energy loss of 5%. The pump drive motor may have to deliver 42 hp instead of 40 hp. Is that saving worth going into refinements that could perhaps affect valve reliability? Certainly, there are exceptions, but they are rare in industrial applications. In submarines, for example, the hydraulic system is supplied from an accumulator for a certain length of time. Internal leakage must be kept very low, and clearances are measured in millionths of an inch.

OPEN-CENTER, CLOSED-CENTER VALVES

A single-stage, jet-nozzle is the extreme of an open-center valve. Maximum flow always passes through the valve. This flow is directed either to the load or drain. The other extreme is a closed-center, 4-way valve that can shut off flow completely and permits only the flow required to position the load.

If a 4-way valve does not close completely but permits some flow to pass continuously from supply to drain, it becomes an open-center valve. Both need jet-nozzle and 4-way valves with rather wide open-

Concluded on page 82

SECOND PRIZE

GIL RISKE

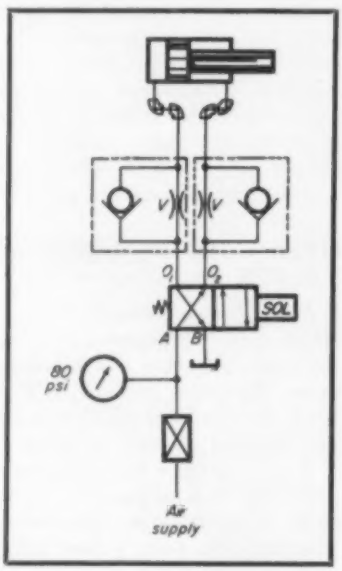
Senior Engineer, Hannifin Co., Div. Parker-Hannifin Corp., Des Plaines, Ill.

Using flow coefficients to design pneumatic systems

Flow coefficients are useful tools for designing a pneumatic system at lowest cost. They eliminate the guesswork in avoiding large pressure drops in valves and plumbing.

THE common way of sizing pneumatic valves and plumbing is to base them on the cylinder or pneumatic tool, port size. This requires checking the system's ability to supply air to the cylinder at the required pressure. If pressure losses in the lines are too great, it becomes a trial and error process to enlarge the pipe sizes and other components. To avoid excessive pressure drops, designers often oversize components.

Cylinders are usually ported for a pipe size large enough to insure currently desired maximum rod speeds and thrusts. When the cylinder porting is established, a designer may follow suit by using the same size porting for the directional control valves, filters, regulators, speed control valves and plumbing. The result is often an oversized and an unnecessarily expensive pneumatic system. Use of flow coefficients gives an equally efficient circuit at greatly reduced cost.



TYPICAL CYLINDER CIRCUIT with 4-way valve control and speed regulation in both directions.

• **Flow Coefficients**—Flow coefficient, C_v, is a constant which relates fluid flow through a component to pressure drop across it:

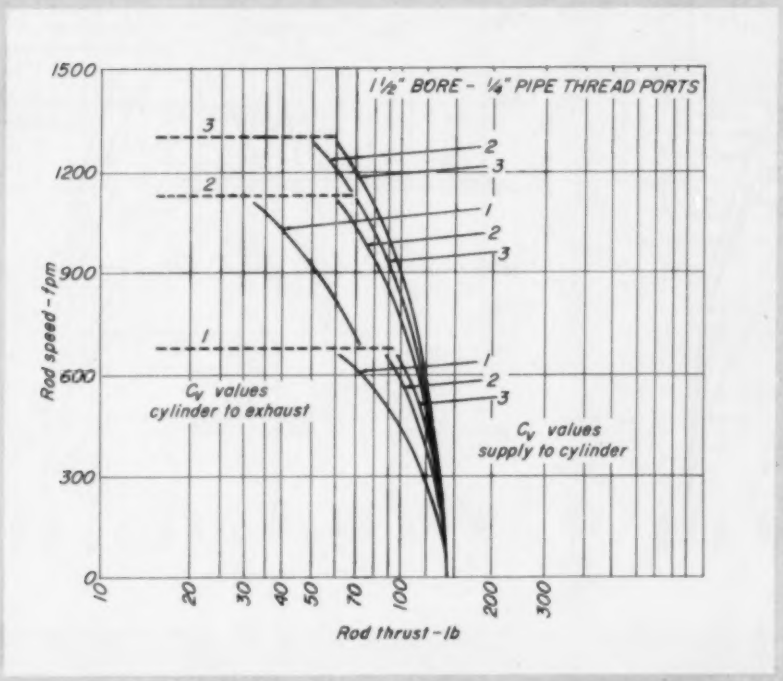
$$C_v = \frac{Q}{22.67} \sqrt{\frac{GT}{(P_1 - P_2)\ P_2}} \qquad (1)$$

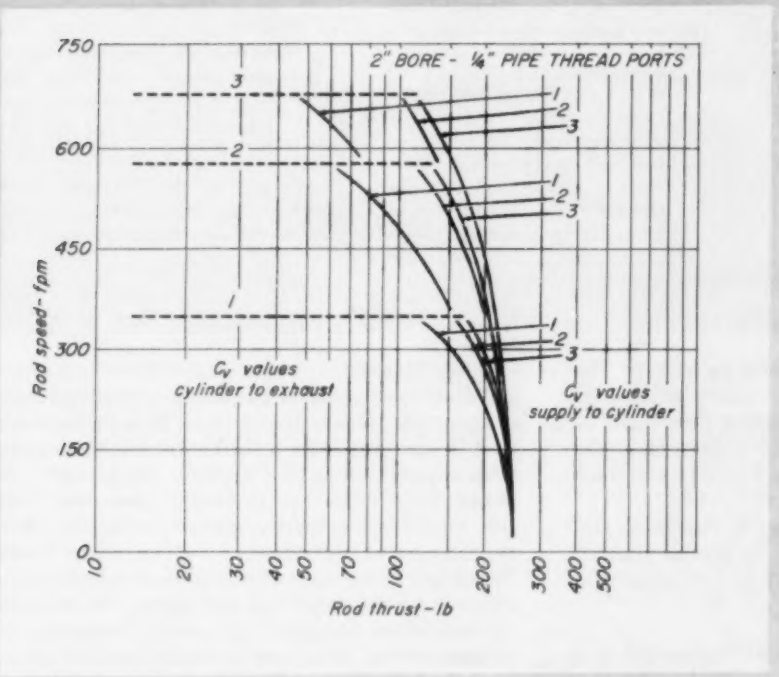
where:

Q = Flow of gas in cfm (14.7 psi at 60 F)
P_1 = Inlet absolute pressure (gage + 14.7)
P_2 = Outlet absolute pressure (gage + 14.7)
Note: P_2 must be greater than 0.53 P_1
G = Specific gravity of flowing medium (air: $G = 1$)
T = Absolute temperature of air (460 + F)

The flow coefficient for a component applies to only one flow path through it. If more than one path is

SELECTING VALVES USING FLOW COEFFICIENTS





Required:

1. **Working thrust of 1750 lbs, horizontally directed to move 18 in. in 3 seconds.**
2. **Return stroke force of 250 lbs, to move 18 in. in 1 second.**
3. **Determine cycle time for this system. Assume valve shift time equal to 5 electrical cycles.**

Given:

Air supply pressure: 80 psig.

Method of solution:

1. **Calculate the minimum cylinder bore for a static thrust of 1750 lbs:**

$$\text{Area (sq. in.)} = \frac{\text{Thrust (lbs)}}{\text{Supply pressure (psi)}} = \frac{1750}{80} = 21.9 \text{ sq. in.}$$

A 6-in diameter cylinder which has a head end area of 28.27 sq. in. is suitable.

2. **Calculate extending speed:**

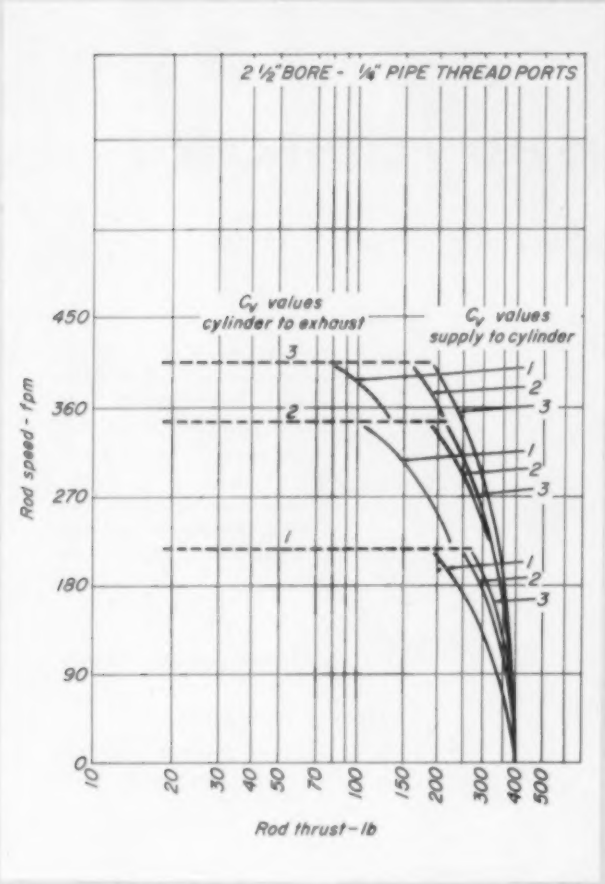
$$\text{Speed} = \frac{18 \text{ in.} \times 60 \text{ sec/min}}{3 \text{ sec} \times 12 \text{ in/ft}} = 30 \text{ fpm}$$

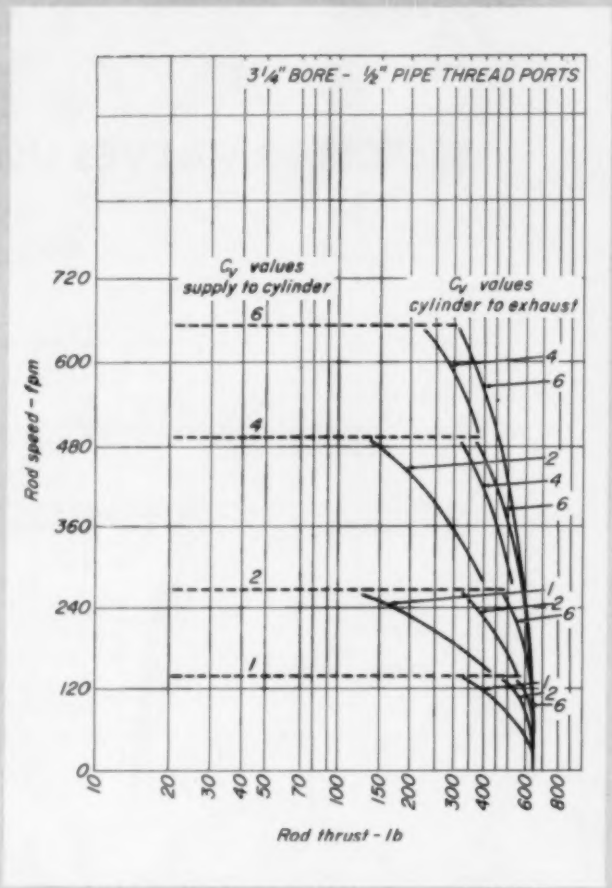
3. **Determine minimum flow coefficient of the combined directional and speed control valves for the cylinder work stroke. Find the point for 1750 lb thrust and 30 fpm speed on the 6 in. cylinder chart. Interpolating, supply C_v is 1.5 and exhaust C_v is 0.75.**

4. **Calculate rod end area required for return stroke thrust of 250 lbs:**

$$\text{Area (sq. in.)} = \frac{250}{80} = 3.13 \text{ sq. in.}$$

Since the piston rod end area, with a 1⅜-in. dia. rod, is





26.79 sq. in., the 6-in. diameter cylinder is suitable.

5. Calculate return stroke speed:

$$\text{Speed} = \frac{18 \text{ in.} \times 60 \text{ sec/min}}{1 \text{ sec} \times 12 \text{ in./ft}} = 90 \text{ fpm}$$

6. Determine minimum flow coefficent of combined valving for the return stroke. At the intersect of 250 lb thrust and 90 fpm speed on the 6 in. cylinder chart, minimum exhaust flow coefficient is 2.25 and the minimum supply flow coefficient is 2.0.

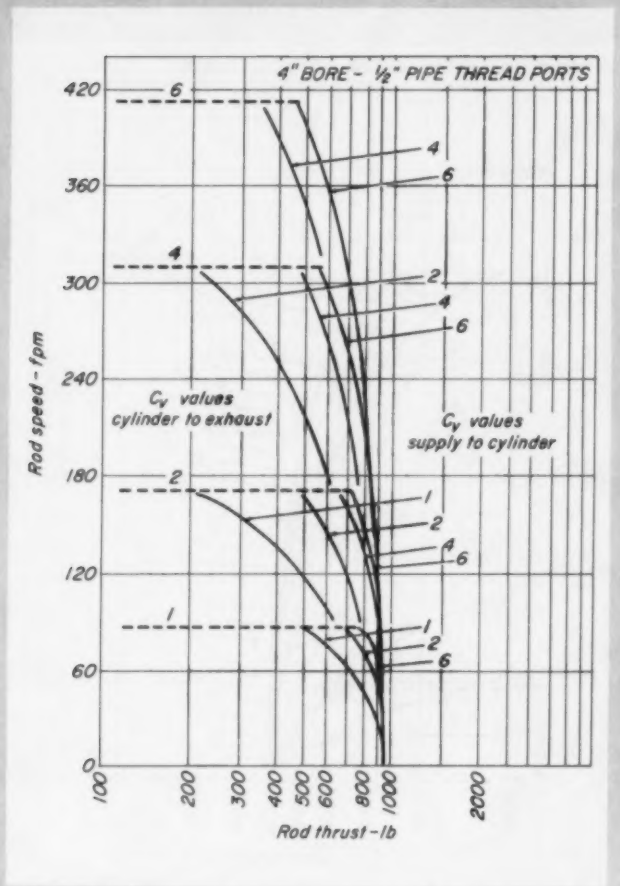
7. Select directional and speed control valves with combined flow coefficient in excess of the minimum ratings from steps 3 and 6. Separate the combined flow coefficients by using the nomogram. Locate the combined flow coefficient on scale *B* or *E*, which cover different ranges. Pivot a straight edge at this point to read corresponding combination of directional and speed control valve ratings on scales *A* and *C*, or scales *D* and *F*.

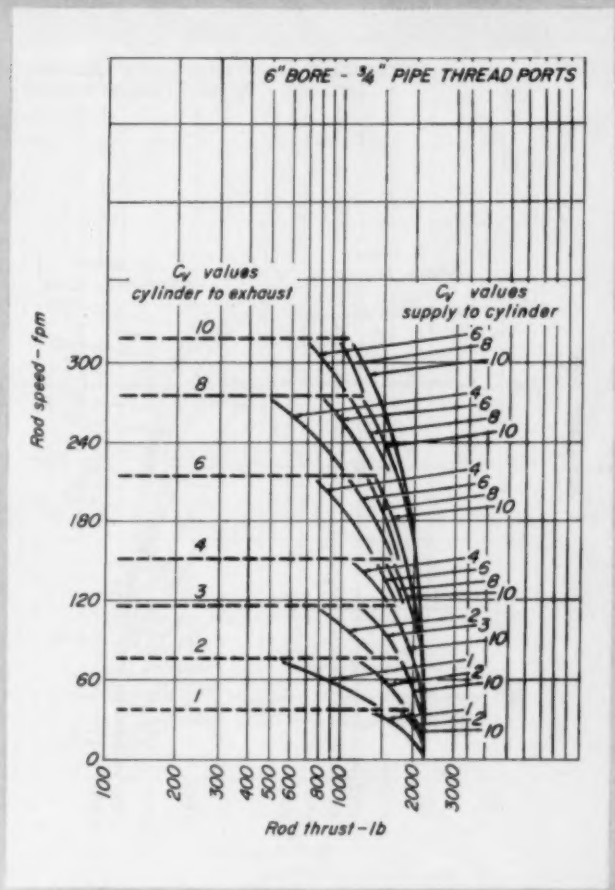
Prepare a table indicating separate and combined flow coefficients of the valves for the various flow

available, the coefficients vary with each path. The same path may have a different flow coefficient in each direction unless it is symmetrical both ways. In pneumatic components, a difference of 10% may exist in the maximum flow rates for each direction through the same path.

The use of flow coefficients largely eliminates random guessing and choosing of component sizes. It enables a designer to select the proper component port for each particular application.

• **Flow Coefficient Charts**—Air cylinders are sized for a specified thrust and speed. But directional valves and speed control valves also affect cylinder performance, so you must consider these in working out a final design. When the cylinder bore is determined from required thrust and available air pressure, the charts of C_v values can be used to determine valve size. Locate on the corresponding cylinder bore chart the intersect of the cylinder's rod speed and thrust. The curves to the right of this point indicate flow coefficients for the supply line and valving. The horizontal lines above the point represent C_v values for the exhaust system. These are minimum values.





paths. Working with data of valves of known flow coefficients, determine by trial and error the combination that meets the minimum capacity ratings for all conditions.

This cylinder should perform to specifications with a 4-way ½-in. NPT directional valve, a ½-in. NPT speed control valve in the line to the head end, and a ⅜-in. NPT speed control valve in the line to the rod end.

8. To calculate cycle time for the 6 in. diameter-18 in. stroke cylinder using a valve shift time of 5 electrical cycles, compute time to energize the valve for cylinder work stroke:

$$5 \text{ cycles} \times \frac{1}{60 \text{ cps} \times 60 \text{ sec/min}} = 0.001 \text{ min}$$

Time to exhaust rod end of cylinder is, from equation (4)

$$E = \frac{1.732 \times 0.092\ (0.186 \times 1.5 + 0.006)}{0.75 \times 1.0} = 0.061 \text{ min}$$

Time for work stroke is

$$\frac{18 \text{ in./stroke}}{12 \text{ in/ft} \times 30 \text{ fpm}} = 0.050 \text{ min.}$$

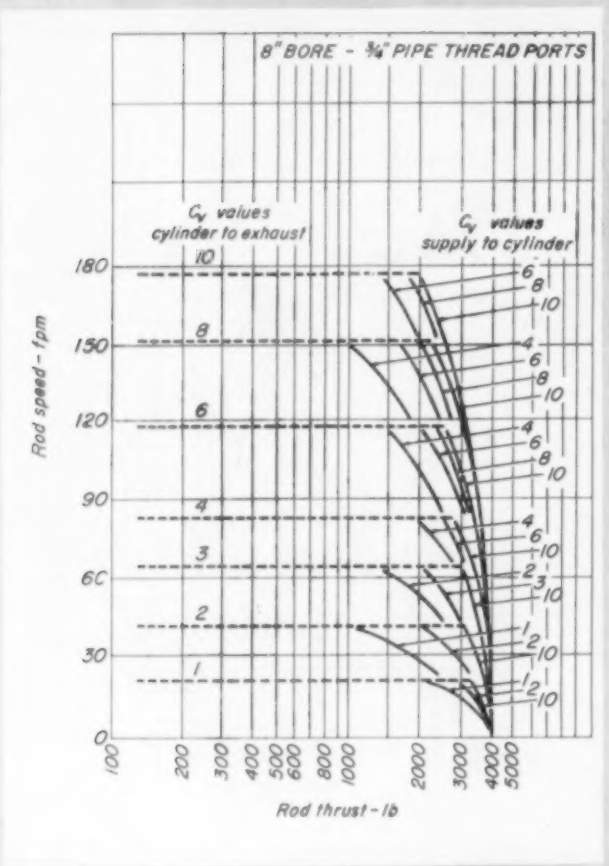
Time to de-energize the valve for return stroke is the same as to energize it, 0.001 min.

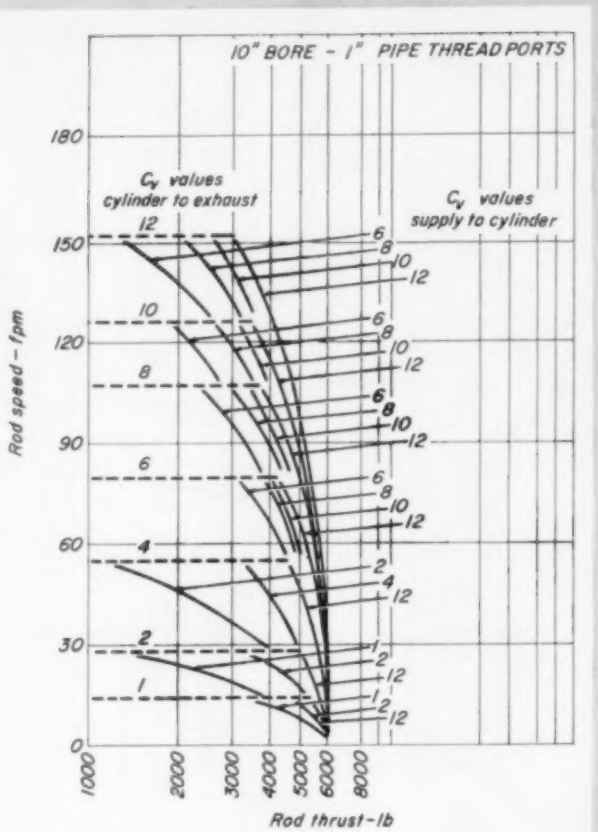
Exhaust system flow coefficients are directly proportional to the distance above the chart zero speed line. System supply flow coefficients are directly proportional to the spacing between two adjacent vertical lines. The next step is to select directional and speed control valves with combined flow coefficients equal to or greater than the minimum values suggested by the chart.

The combined flow coefficients can be separated into valve and speed control flow coefficients by using the nomogram. Locate the combined coefficient on scale B or E and pivot a straight edge at this point to read corresponding combinations of valve and speed valve ratings on scales *A* and *C*, or scales *D* and *F*.

Only the valves can be sized differently than shown. The original pipe diameter should be maintained even though it means the use of bushings and reducers at the valves. Exception may be made with the use of close nipples at the component ports as well as to connect a directional and speed control valve directly. Longer lengths of the reduced diameter pipe may adversely affect the capacity of the pneumatic system.

• **Air Supply Pressure**—Different applications ob-





Time to exhaust head end side of cylinder, using equation (4)

$$E = \frac{1.732 \times 0.092\ (0.196 \times 1.5 + 0.006)}{2.50 \times 0.98}$$

$$= 0.016 \text{ min.}$$

Time for return stroke is

$$\frac{18 \text{ in./stroke}}{12 \text{ in./ft} \times 90 \text{ fpm}} = 0.017 \text{ min.}$$

Minimum time/cycle is total, or 0.146 min.

Maximum number of cycles/min:

$$\frac{1}{0.146 \text{ min/cycle}} = 6.85 \text{ cpm}$$

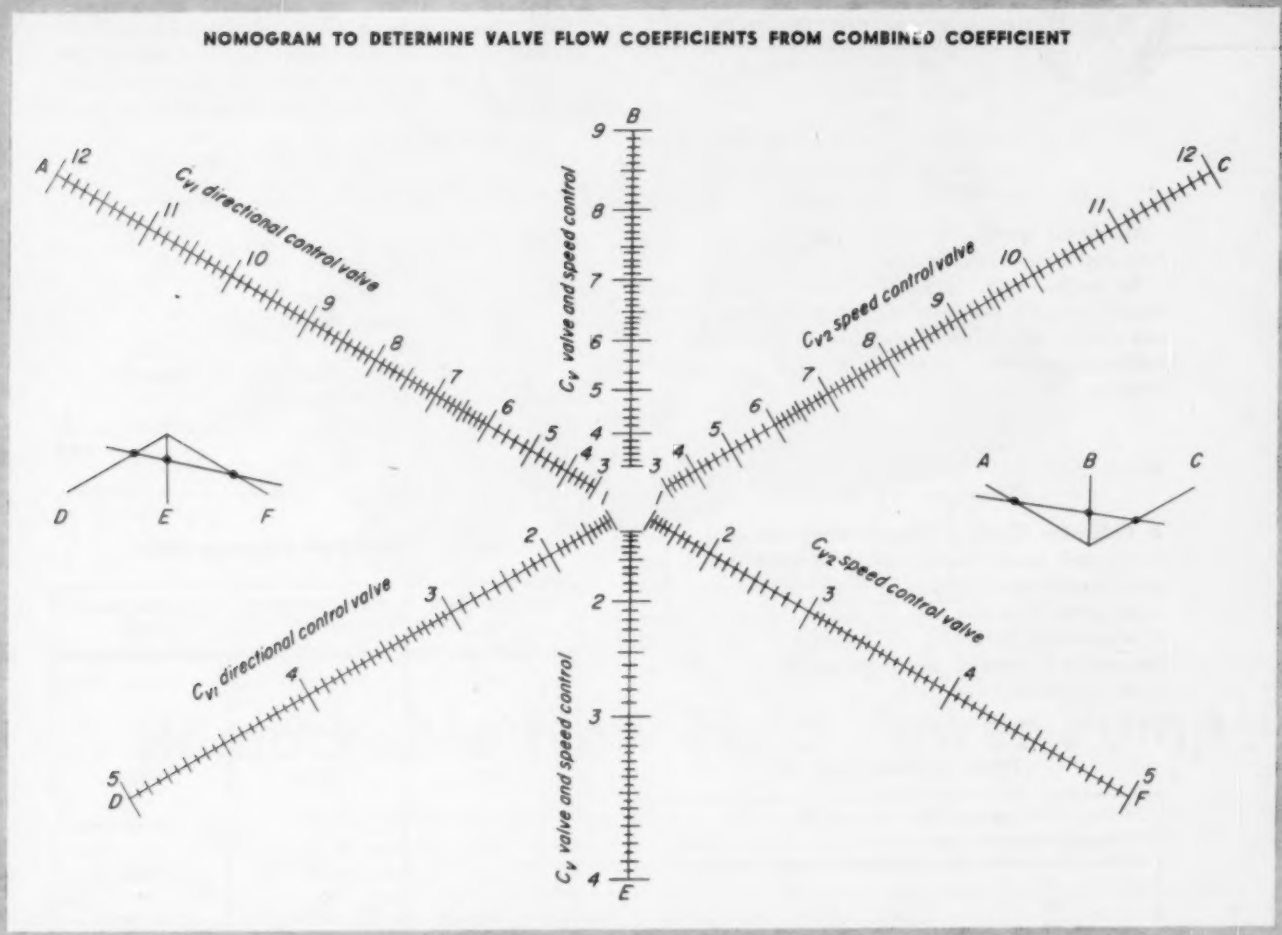
In this example, the total exhaust time is 53% of the cylinder cycle time. To shorten the exhaust part of the cycle, two methods are available:

1. **Use a quick exhaust valve**
2. **Use a pressure regulator in the cylinder rod-end line. This will conserve compressed air and limit free air volume that must be exhausted.**

viously require various supply pressures. The accompanying charts are based on pressure of 80 psi at the directional valve inlet. Since the speed control valve is usually designed with a spring-loaded check in the free flow direction, the actual inlet pressure at the directional valve should be slightly higher to compensate for the pressure drop created by the spring. Depending on design, speed control valves may have up to 10 psi pressure drop in the free flow direction. Speed control valves should be rated with flow coefficients for two conditions: (1) the wide open setting in the restricted flow direction and (2) in the free flow direction with the metering valve fully closed and the check valve spring removed.

The charts were prepared for supply pressure directed to the cylinder head end. However, they may

NOMOGRAM TO DETERMINE VALVE FLOW COEFFICIENTS FROM COMBINED COEFFICIENT



Flow path through valve	Nomogram Values			Valve Ratings		
	Scale E Combined C_v	Scale D Directional valve C_v	Scale F Speed control valve C_v	Directional valve C_v	Speed control valve C_v	
				⅛" NPT	¼" NPT	⅜" NPT
A to O_1	1.5	1.80	2.63	4.7	4.2[1] to 4.5[3]	—
O_2 to B	2.50	4.6	3.00	4.6	3.00[2] max	—
A to O_2	2.0	4.7	2.25	4.7	—	2.63[1] to 3.82[2]
O_1 to B	0.75	4.6	1	4.6	—	2.44[3] max

1—Free flow (Needle closed—No valve spring)
2—Restricted flow through needle valve)
3—Free flow plus full open needle valve—no valve spring

also be used where the air supplies the rod ends. The flow passages in the cylinder heads are considered as full pipe cross section area minimum. The cylinder length does not exceed two feet so as to limit the length of the pipe from the control valve. The pipe is installed exactly as illustrated in the nominal diameter indicated.

• **Thrust for other Supply Pressures**—Where air supply pressure is other than 80 psi maximum thrust at maximum speed is:

$$T_2 = \frac{(P_s - 25)\ T_1}{55} \qquad (2)$$

where: T_1 = Maximum rod thrust (lb) read on chart at desired maximum speed.

USING FLOW COEFFICIENTS

T_2 = Maximum rod thrust (lb) at same speed but with supply pressure P_s
P_s = Actual air supply pressure (psig).

Maximum speed remains constant because exhaust flow coefficient remains constant.

To use the curved lines of the charts, when changing supply pressure, determine the intersect of the straight and curved lines by equation (2). Also determine the maximum rod thrust at static condition (zero speed) with the following equation:

$$T_3 = A \times P_s \qquad (3)$$

where: T_3 = Static rod thrust—lb.
A = Piston area—sq. in.

• **Cylinder Cycling Time**—After choosing directional and speed control valves to meet thrust and speed requirements, it may be found that reversal time is too great. This occurs at the end of the stroke, when it is necessary to reduce air pressure on one side of the piston to provide the required thrust in the reverse direction.

TABLE I—VALUES FOR K_1

(Exhaust Time Constant) Supply Pressure—psi	K_1
40	0.050
60	0.074
80	0.092
100	0.107
120	0.12
140	0.13
160	0.14

The time to exhaust the cylinder depends on flow capacity of the components in the exhaust line and the volumes of the pipes and cylinders. Because exhaust time may be considerable, it should be calculated from the following equation:

$$E = \frac{1.432\ K_1\ (A\,S + R).}{C_v\ K_2} \qquad (4)$$

where: E = Exhaust time, minutes
K_1 is found in Table I
K_2 is found in Table III
A is found in Table II
S = rod stroke
C_v = Combined exhaust valve system flow coefficient
R = Pipe volume from valve to cylinder, cu. ft.

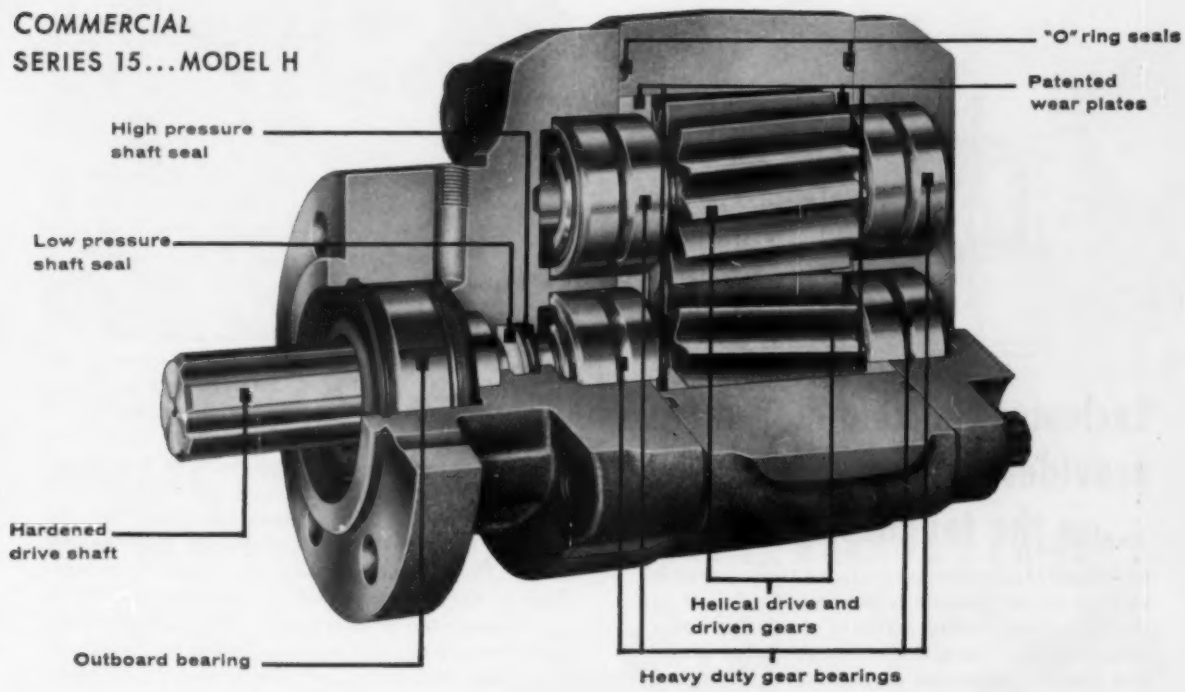
▼▼▼

TABLE II—AREAS OF CYLINDER BORES

Cylinder Bore —in.	Head End Area —ft.²	Rod End Area —ft.²
1½	0.012	0.010
2	0.022	0.020
2½	0.034	0.032
3½	0.057	0.051
4	0.087	0.082
6	0.196	0.186
8	0.365	0.349
10	0.545	0.528

TABLE III—CORRECTION FACTOR K_2 FOR NOMINAL PIPE DIAMETERS

Combined valve C_v	¼ in.	½ in.	¾ in.	1 in.
1	0.94	1.00	1.00	1.00
2	0.77	0.95	0.98	0.99
3	0.60	0.90	0.96	0.98
4		0.85	0.94	0.97
5		0.80	0.92	0.96
6		0.75	0.90	0.95
7			0.88	0.94
8			0.86	0.93
9			0.84	0.92
10			0.82	0.91
11				0.90
12				0.89
13				0.88
14				0.87



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Matched helical gears having mirror finish ground on all surfaces contribute to high volumetric efficiency and quiet operation. Thus, complete sealing is maintained—tooth to tooth and tooth to gear housing. Ruggedness, greater load capacity and dampening of unbalanced internal loading are assured by using integral gear hubs to serve as journals for the pump's oversize gear bearings. In order to meet its own exacting standards, COMMERCIAL must, and does, produce its own gears.

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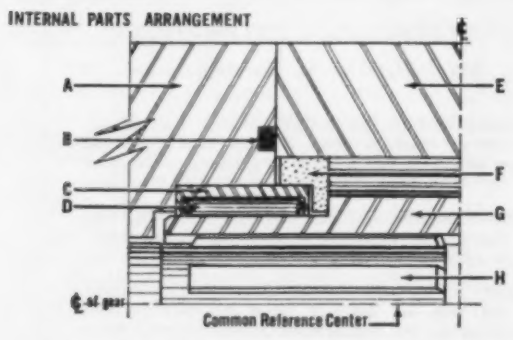

pumps, valves, cylinders, motors

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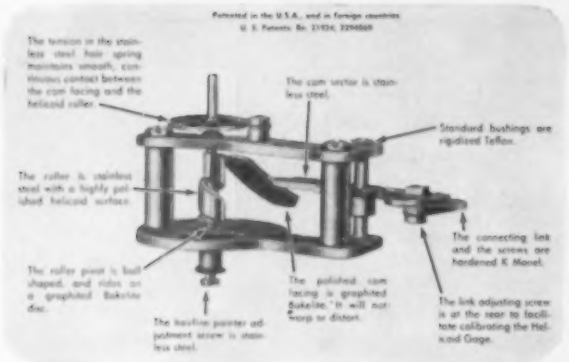
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PRINCIPLES OF SERVOVALVES

Continued from page 73

center needs full travel for maximum pressure across the load. With a closed-center 4-way valve, it is possible to obtain maximum pressure across the load with even the smallest displacement. *In all cases, maximum flow to the load does not coincide with maximum pressure across the load.* The more pressure that is required across the load, the slower the flow. Only when the load is at a standsill, can pressure across it be maximum. The similarity between pressure-flow curves for jet nozzle and open-center, 4-way valves does not imply that the effects of these valves are quantitatively the same. This depends on how much of an open center there is in the 4-way valve.

Open-center and closed-center valves are hard to compare because they have basically different behavior. The closed-center valve is normally in its mid-position. On an input signal to reposition the load, it opens, passes the necessary fluid, and closes. Once the load is repositioned, it is firmly locked by the closed-center four-way valve, and this is one of the great advantages of a tight, closed-center valve.

An open-center valve can stay at mid-position only as long as there is no load on the actuator. Holding the actuator against a load requires a valve displacement. So an open-center, valve system is always "alive." It responds to any load changes. Certainly, there are limitations. The valve cannot bounce all over with every little load change. But before an open-center valve is condemned because of its load-sensitivity, it must be related to the particular control system under consideration.

Dead space, or ineffective travel at mid-position, on the other hand, has very detrimental effects on the dynamic performance of a closed center valve. It is practically impossible to design a closed-center valve without dead space. Even if it could be built, erosion would soon make it an open-center valve.

Because of flow forces a 4-way valve must generally have two stages. Deciding between an open-center or closed-center valve is often a question of whether a single-stage or a two stage valve should be used. Price difference becomes an important factor. ▼▼▼

HYDRAULICS & PNEUMATICS

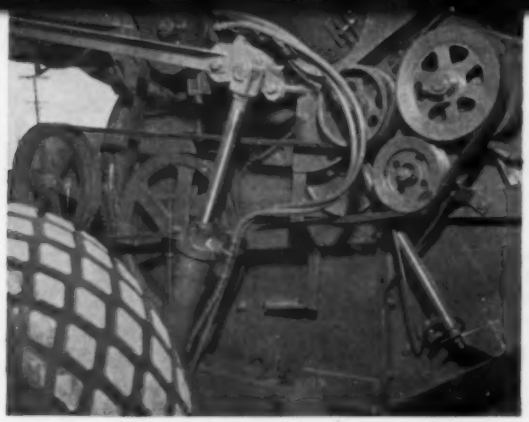
will feature in the November issue

SINGLE-STRAND TENSIONING of steel rods in prestressed concrete beams. A single, small hydraulic cylinder is simpler, faster, and more accurate than four large rams that tension many rods at a time.

CONTAMINATION: A HISTORY OF THE PROBLEM. The first installment of a series on contamination in missile hydraulic systems.

HOW TO SELECT QUICK-CONNECT COUPLINGS will help the designer select the coupling most suited for his requirements. Cross-sectional drawings point out features of the various designs.

Circle **64** →



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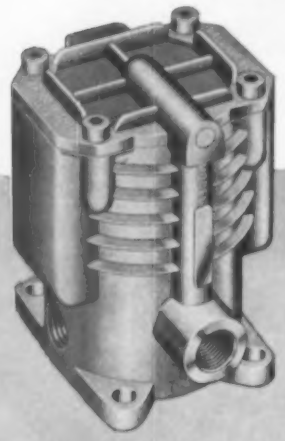
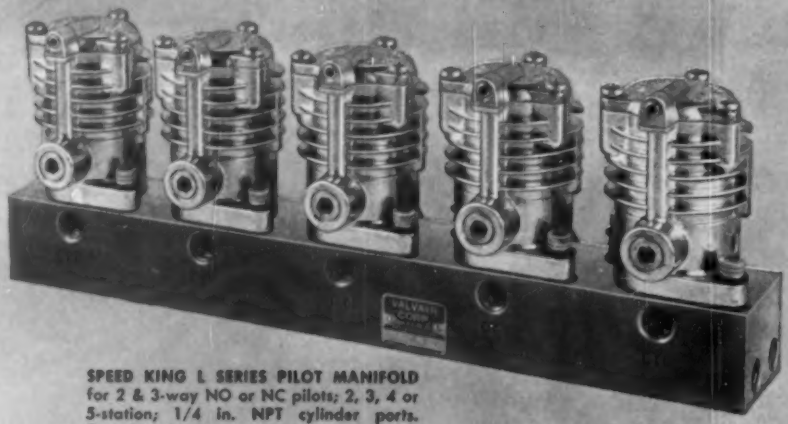
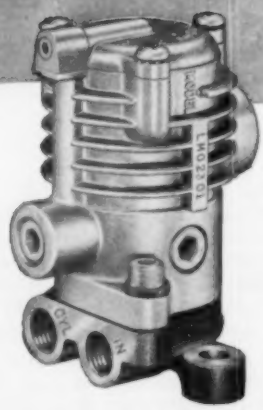


SPEED KING P SERIES PILOT 2 & 3-way NO & NC, 4-way; foot, sub-base or manifold mounting; 1/8 or 3/16 in. orifices. Foot mounting shown.



SPEED KING L SERIES PILOT MANIFOLD for 2 & 3-way NO or NC pilots; 2, 3, 4 or 5-station; 1/4 in. NPT cylinder ports. 5-station shown.



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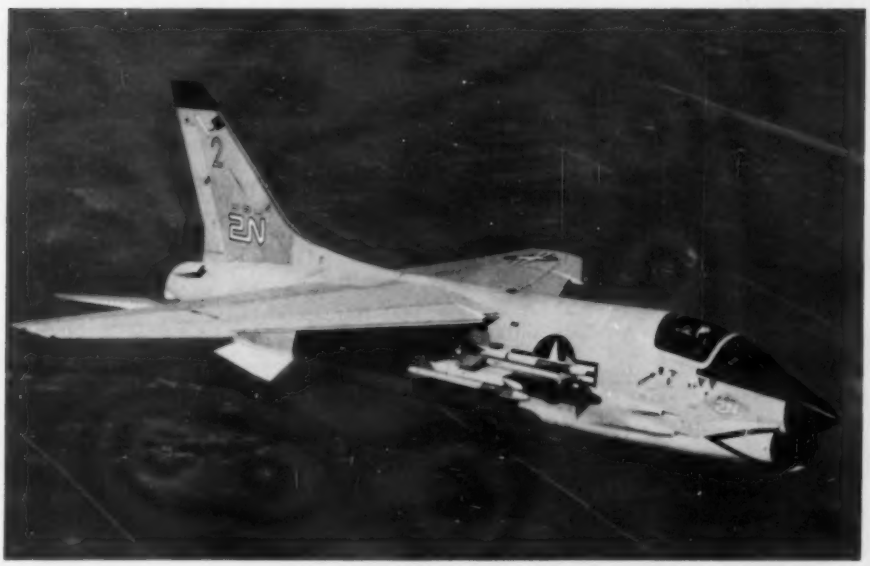
8112-3

THIRD PRIZE

J. R. CRISSEY,
Engineering Design Specialist, Chance Vought Aircraft, Inc., Dallas, Texas

Designing dampers to stabilize a jet fighter

Instability and high friction were two problems solved by valve dampers on the F8U-2. Their design was based on the right choice of materials, fluid medium and seals.



ALL WEATHER JET FIGHTER built for the Navy by Chance Vought Aircraft Inc., carries four missiles and can be carrier based.

SHORT stroke cylinder cycling causing control surface "buzz" was the sign that valve dampers were needed for the Crusader all-weather fighter. The short stroke cycling was being caused by instability in the pilot input signal to the elevator control. A damper was needed between the input rod and the servovalve shaft. Damping had to be small enough, however, not to feed back damping and friction forces to the pilot. Friction had to be near zero through the temperature range of —65 F to 315 F.

The three major problems were:

A. Material expansion
B. Fluid
C. Seals

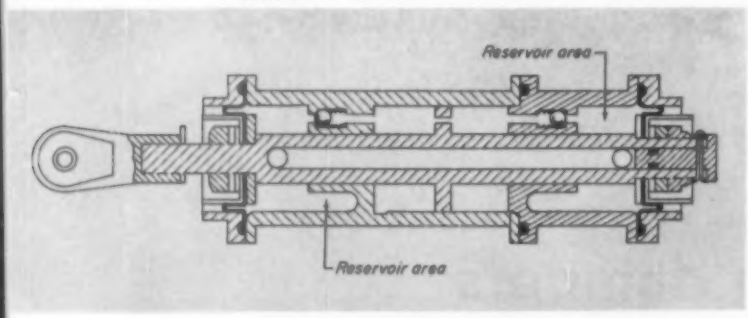


FIG. 1. INITIAL VALVE DAMPER DESIGN was self-contained. It had a double ended piston and a reservoir chamber at each end.

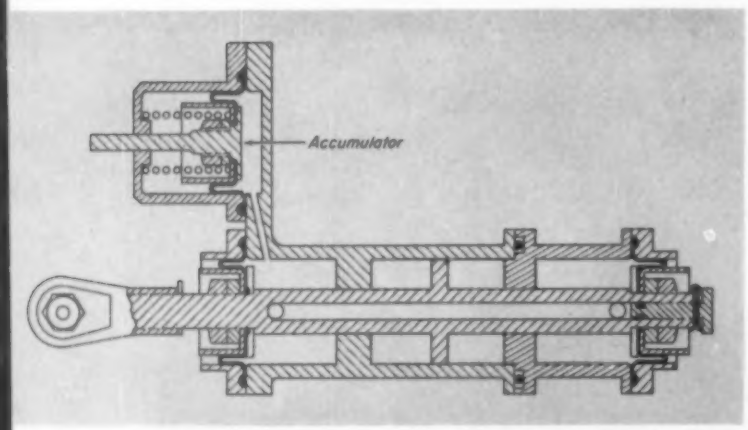


FIG. 2. ACCUMULATOR AND DIAPHRAGM SEAL helped reduce breakout friction.

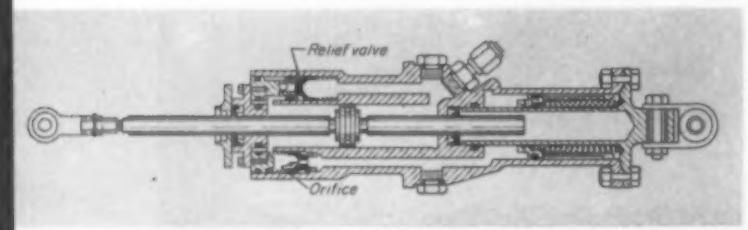
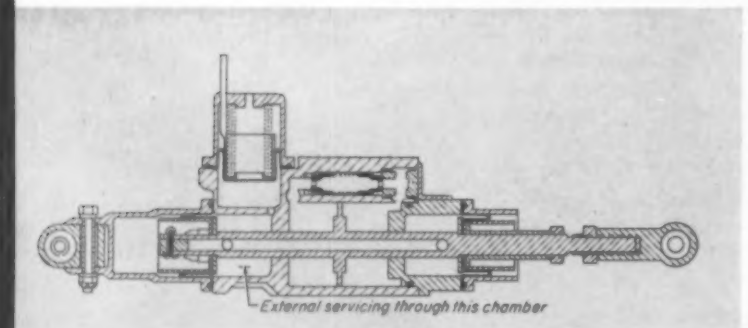


FIG. 3. ORIGINAL BOBWEIGHT DAMPER had low friction O-rings and U-cup rod seals.

FIG. 4. O-RING AND ACCUMULATOR SPRING were removed from final bobweight damper design. Provisions were made for external filling and servicing.



• **Initial Damper Design**—We decided to use a self-contained damper, Figure 1, with a double rod. The damper had a reservoir at each end outside the piston rod bearings. These were interconnected through the piston rod. All parts were made of stainless steel to control delta coefficient of expansion. The piston rods were chrome plated for hardness. A fluid with a low viscosity change of 550 centistokes through the 380 F range was selected. Diametral piston clearance was held to 0.0002-0.0006 in. Because O-rings were omitted, this close tolerance was necessary to eliminate orifice effect. The piston rod diametral clearance was held to 0.0004-0.0012 in. with the rod guide or bearing area. The two rod ends were sealed with diaphragm seals to keep friction at a minimum. The dampening orifice across the piston was made 1/16 in. diameter. The damper was assembled and filled while submerged under oil, to avoid trapping air in the system. This minimized the effect altitude and temperature might have on the air in the fluid.

Bench testing the original design showed a full-stroke dampening time of 5 to 6 seconds, and a breakout friction of about 2 ounces depending on cycling. Short stroke cycling increased friction to 1½ lb and resulted in galling. An investigation showed lack of lubrication. According to the fluid manufacturer, this was due to the damper material. The fluid would not lubricate chrome plated rods and stainless steel bearings.

Berrillium-copper and Teflon bearings were made, then abandoned when it was decided to switch to MIL-H-5606 fluid.

• **Redesign For MIL-H-5606**—Using a new fluid, required increasing the piston orifice to 0.07 in. diameter and the piston clearance to 0.003 in. to reduce full stroke dampening time. The piston head peripheral thickness was reduced to 0.06 in. to reduce viscous effect of oil flow across the piston. This reduced full stroke dampening time to 1½ seconds, and breakout friction to 2 ounces. Short stroke cycling tests showed neither galling nor friction increase. Testing in an oven, however, produced friction increase and seal ballooning. There had been no provision for the difference in thermal expansion between MIL-H-5606 and the original fluid.

• **Accumulator Added**—A redesign added an accumulator with a rolling seal for thermal expansion, shown in Figure 2. Seals were made from an elastomer with improved temperature properties. Clearance between the inside and outside guide of the seal cavity was increased to permit better rolling of the seal.

The accumulator was pressurized to 3 psi. Testing showed that breakout friction increased to 3 ounces and full stroke dampening time to 1.6 seconds. Temperature cycling caused no ballooning of the diaphragm seals nor increase

in friction. Production units checked out with an average full stroke dampening time of 1.4 seconds and breakout friction of 3 ounces.

• **Redesign of the Dampers**—After designing the elevator valve damper, we applied our experience to redesigning the longitudinal control stick and aft bobweight viscous dampers. The original damper, Figure 3, with low friction O-rings and rod U-cup seals, had a full stroke dampening constant of 25 and a breakout friction of 1½ to 2 lbs. This high friction caused slow dampening time, and control stick recentering time of 1 minute.

The O-ring was removed from the piston head. U-cup seals were hand lapped. Accumulator pressure was reduced by removing one of the accumulator springs. Full stroke dampening constant was reduced to 12, and breakout friction went down to 0.35 lb. The control stick re-centered in about 15 seconds. The redesigned damper also saved assembly and filling time by permitting external pressure filling and servicing. The main design improvements were:

A. Use of aluminum.
B. An orifice in the barrel interconnecting ports, and
C. Pressure relief valve.

Poor bonding between layers of rubber caused the rolling diaphragm seal to leak. This was remedied with a one-piece, injection molded seal. Pressurizing the accumulator to 20 psi eliminated cavitation at high altitude and high frequency vibration, (greater than 5 cps.). Increasing the internal pressure also increased friction.

7 Points For Good Damper Design

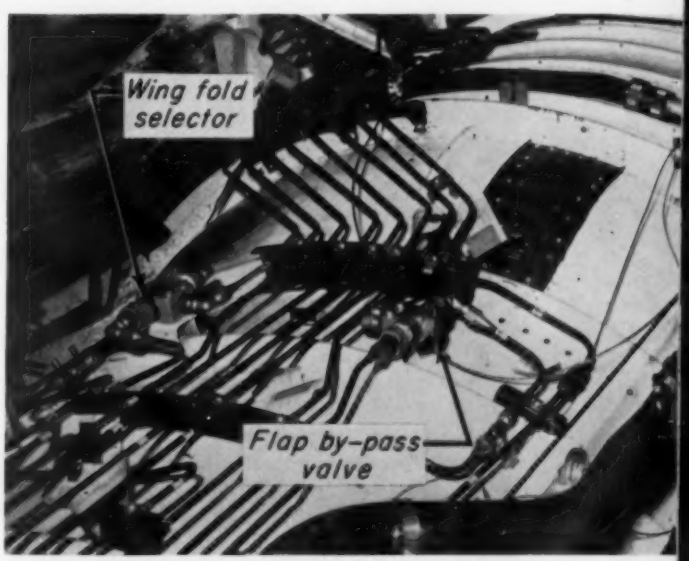
1. Elastomer material must have good high and low temperature properties and be compatible with the fluid.
2. Rolling diaphragm seals should be molded in one piece. They should have an inner bead for positive rod sealing, and controlled tolerances to eliminate wrinkling.
3. Clearance between guides should be ample to permit the diaphragm seal to roll.
4. Orifice effect should be kept at a minimum.
5. The damper must be thoroughly bled of air.
6. Provisions should be made for fluid thermal expansion.
7. Eliminate cavitation at high altitudes by pressurizing the accumulator, although this increases friction.

THE CRUSADER'S HYDRAULIC SYSTEM AND COMPONENTS

The Navy F8U-2 has dual power control systems to actuate control surfaces. For reliability, they are independent and can each control the plane alone except under maximum g pullouts.

One system may be powered by an emergency ram air turbine. Both systems operate at 3000 psi, and use MIL-H-5606 fluid, cooled in flight by a flowing fuel cooler. The fluid can not be transferred from one system to the other. Each system is supplied by a variable volume, engine driven pump.

Control circuits are actuated by closed-loop circuits having a mixing linkage, valve, actuating cylinder and



HYDRAULIC INSTALLATION UNDER WING shows wing fold selector, flap bypass valve and plumbing.

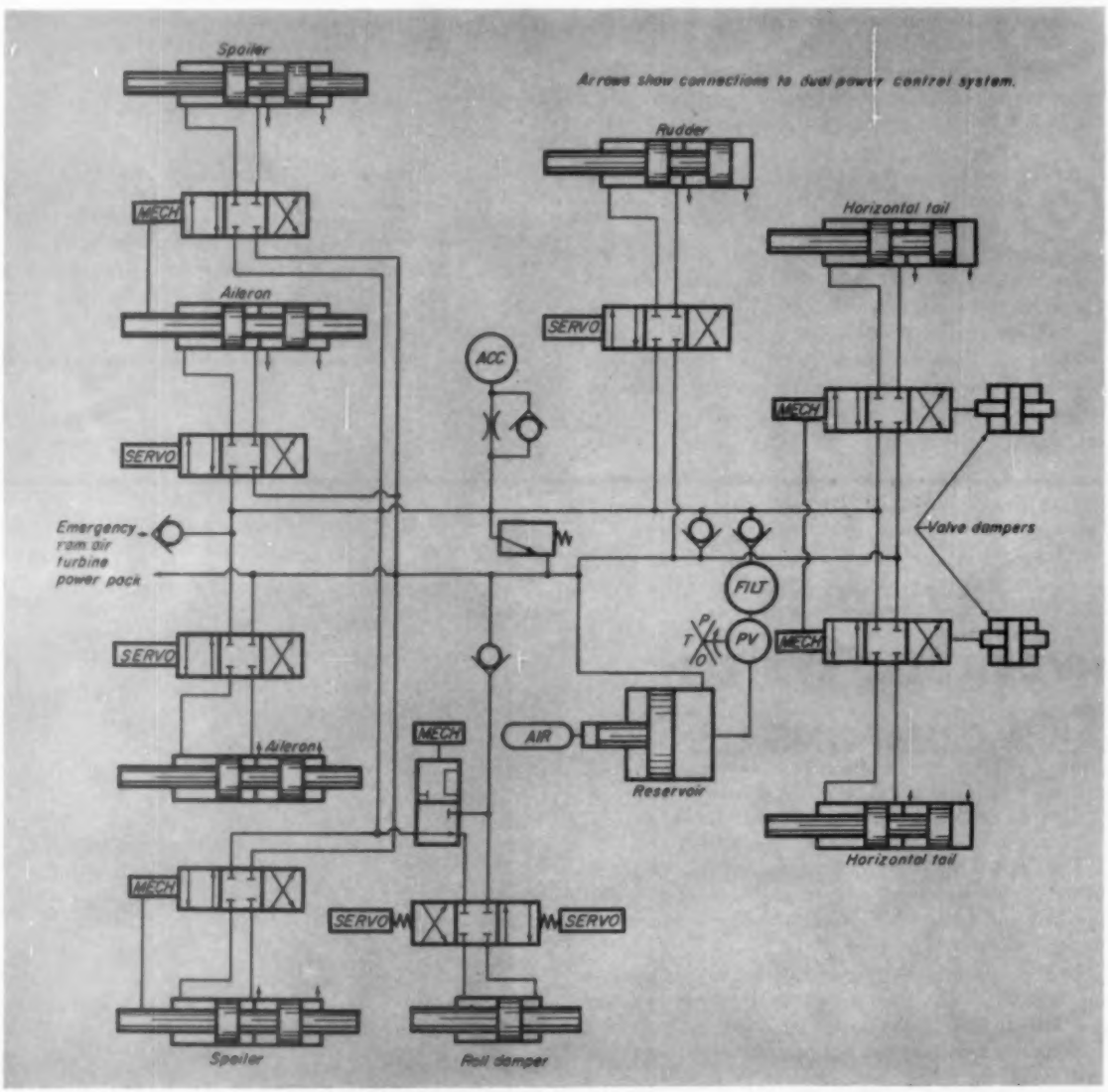
External servicing through this chamber

DESIGNING DAMPERS

follow-up rod. The input rod transmits control stick motion to the valve through the mixing linkage. Input signals may also originate from a trim-stabilization actuator. The valve controls flow to the cylinder which positions the surface. At the same time, the follow-up rod pivots the mixing linkage, returning the valve to neutral. Surface displacement is thus proportional to control stick displacement. The structural feedback linkage on the elevator system and the force feedback unit on the aileron and spoiler servovalve improve stability.

A utility circuit is a conventional "closed loop" circuit, operates at 3000 psi, and uses MIL-H-5606 fluid. It powers the ventral fins, speed brake, missile launching, landing gear, and wheel brakes. It also operates the wing fold, flaps, two position wing, leading edge droops, arresting gear, and inflight refueling. It also actuates the engine bypass doors, nose gear steering, and radar antenna which are electrohydraulic type servo systems. It is equipped with a hand pump circuit for ground operation without external power.

A nitrogen emergency circuit extends the emergency power unit, actuates secondary control surfaces in an emergency. Operated by nitrogen-charged stor-



POWER CONTROL SYSTEM has twin circuits for reliability. Each circuit actuates one section of the tandem cylinders. System shown has ram air turbine power pack and the roll stabilization system. Alternate system actuates pitch and yaw stabilization and aileron rudder interconnect.

age bottles, it uses four bottles for seven circuits. The bottles are covered by an electric blanket and insulated to protect against temperature extremes. For safety, one bottle extends the emergency power unit and another operates the ventral fins. The other two bottles are divided by circuits so that a wheels-up or a wheels-down landing can be accomplished when one of the bottles is inoperative. The bottles can be recharged. Dry nitrogen is used instead of compressed air to reduce moisture content and eliminate dieseling effect.

• **Filtering Design**—A filter is installed in each of the main pressure lines and in each of the pump recirculating lines. The high pressure filter is rated at 15 gpm, 5 microns. The filter removes 98% of the particles from 5 to 25 microns. It has a stainless steel wire mesh element which attaches with a quick disconnect feature. A mechanical indicator is set for a differential pressure of 90 psi which shows the filter should be cleaned. The filter does not bypass fluid.

The pump recirculating filter protects the system from particles generated in the pump. It is rated at 1.5 gpm, 10 microns. It also has a stainless steel wire element which removes 98% of particles from 10 to 35 microns. It has a bypass valve that relieves at 50 psi differential pressure. An indicator shows the filter has bypassed.

• **Servovalves**—Two-stage, dry coil, electrohydraulic servovalves actuate the nose gear steering, engine air bypass doors, radar antenna, and stabilization circuits. The surface control cylinders have mechanical, servo, slide valves finished to 0.00005″ diametral clearance between sleeve and slider. Fine finish of slider holds end spool leakage to three drops per hour.

The valves are of a side-by-side design because of the dual systems. They are bolted to the cylinders so that they may be removed for synchronizing without having to remove the entire cylinders.

The aileron and spoiler mechanical servovalves have a pressure feedback unit which acts as a structural feedback element through the stroke. The pressure feedback unit has two springs separated by a piston. The pressure feedback piston senses pressure from the cylinder and translates it into the linear displacement of the servovalve sleeve. Pressure feedback senses and compensates the structural deflection. This design decreases system spring rate until it bottoms. Spring rate then begins to increase.

• **Bootstrap Reservoir**—This oil storage container replaces oil lost due to system leakage, make up for volume differentials, and maintains a constant back-pressure on the system and pump. It is pressurized by the system to 70 psi in the surface control system, and 40 psi in the utility system. A relief valve prevents the reservoir to overpressure.

• **Plumbing Design**—Tubing was selected one size smaller than called for by MIL-H-5440 and performs satisfactorily. In addition, going to one size smaller in stainless steel permitted using a thinner wall with approximately the same cross sectional area. This saved weight on 3/8 in. tubing and larger. To prevent crossing lines, during system assembly, MS fittings were used for high pressure lines and AN fittings for the return and suction lines.

Coiled tubing is used instead of flexible hose wherever possible. This is lighter and more reliable.

• **Cylinders**—Instead of using established specifications, cylinders were qualified to a temperature-stroke-load spectrum compatible with environment, load, and life of the airplane. A factor of 3 was added to the anticipated spectrum. The spectrum was established for both endurance and fatigue cycling. Because the surface control cylinders are at higher temperature, cycling was established on the basis of 15% at the maximum temperature and 85% at the intermediate temperature. The utility cylinders and pneumatic cylinders which are at lower temperatures had a cycling program of 10% at maximum temperature, 20% at intermediate temperature, and 70% at room temperature. Cycling was according to the actual airplane motions and used the attaching fittings for the qualification jigs so that the fittings were also qualified with the cylinder.

• **Corrosion Protection**—In the initial design, to protect all areas except those under impact, exteriors of aluminum cylinders were anodized and primed. The bores were protected with sulphuric anodize. Aluminum piston rods have copper-nickle-chrome on sliding surfaces and sulphuric anodize on non-sliding surfaces. A transition area of alodine is used between the two surfaces. Aluminum pistons have a copper strike on the lands and then a chrome plate. Packing grooves have alodine. Piston faces and end caps are protected with sulphuric anodize.

In the initial design, steel cylinder barrels were manufactured from corrosion resistant material. The sliding surfaces of steel piston rods have hard chrome, the non-sliding areas have electroless nickle. Steel pistons have hard chrome on the lands. Packing grooves and piston faces have electroless nickle. End caps are made of corrosion resistant material or have electroless nickle plate. The cylinder locking fingers, cams and pistons are tin plated or made of corrosion resistant material depending on contacting surfaces and fatigue strength.

The final corrosion protection program includes the initial design in addition to protecting impact areas. The steel plating program will include chromizing, tin plating, electrolizing, electroless nickle and hard chrome plating. The aluminum protection program will include electroless nickle, chrome plate, sulphuric anodize and hard anodize. ▼▼▼

JOHN J. PIPPENGER
Director

16th National Conference Industrial Hydraulics

FRANK L. MACKIN
Associate Director

WILLIAM R. SMITH
Secretary

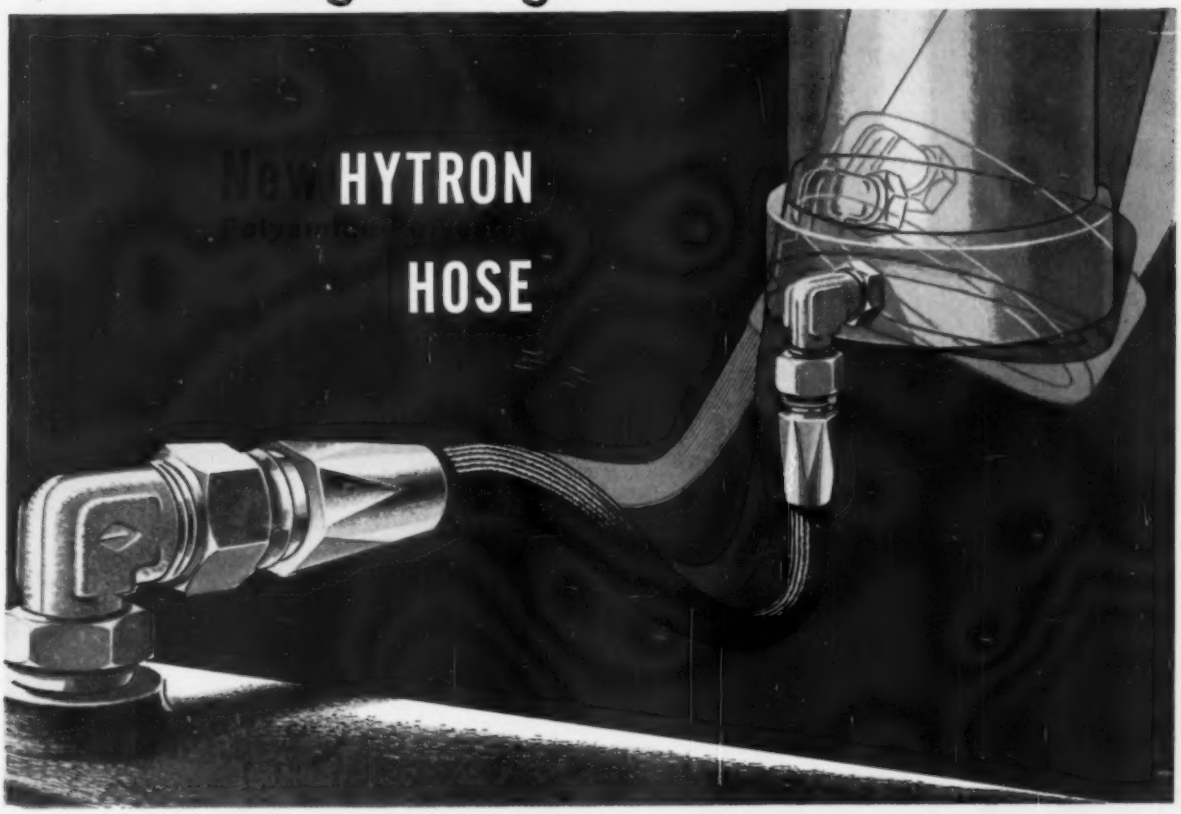
DESIGN FOR CLEANLINESS IN FLUID POWER SYSTEMS is the theme of the 1960 NCIH meeting. The two-day conference, on October 20 and 21 at Sherman Hotel, Chicago, will meet in 12 technical sessions, a banquet, and two luncheons. The 25 papers will present advanced information on contamination, filtration, and latest fluid power applications.

The conference is sponsored by the Graduate School of Illinois Institute of Technology and Armour Research Foundation of IIT. The Illinois and Chicago chapters of many national engineering societies are cooperating also. Purpose of these conferences, started in 1945, is to exchange information on the latest developments in the fluid power field.

Director of the 16th Conference is John J. Pippenger, Vice President and Director of Sales, Double A Products Co. Associate Director is Frank L. Mackin, Chairman, Engineering Shops, General Motors Institute. William R. Smith, Director of Cooperative Education of Illinois Tech, is Conference Secretary.

Program and abstracts of the conference papers are given on the following pages.

IMPERIAL
Engineering and Data File



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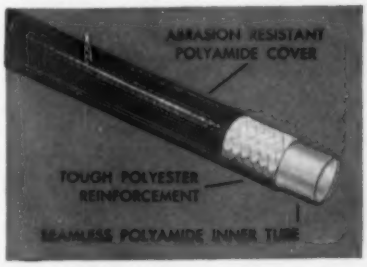
After 57.4 hours the S.A.E. 100R5 single wire braid rubber hose burst near a coupling. It took 415.5 hours — *over seven times as long* — before the Hytron hose failed.



Note that there is *no wire braid* in Hytron hose. This eliminates one of the major causes of fatigue failure. Hytron is 80% lighter in weight, and, unlike wire braid rubber hose, retains virtually all of its flexibility under pressure.

Imperial Hytron hose operates in a burst pressure range from 9000 to 12,000 psi, depending on size and temperature. It is recommended for continuous service with fluids from −40 to 225°F, and for intermittent service to 250°F. Hytron is unaffected by nonflammable hydraulic fluids up to 180°F and flammable fluids up to 225°F.

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Components and Accessories

P. ROLNICK
Machine Tools

E. WIEDMANN
Pumps

PROG

NATIONAL CONFERENCE ON

THURSDAY, OCTOBER 20, 1960

8:00 A.M. Registration: Sherman Hotel, Chicago.

9:00 A.M. GENERAL SESSION

Opening: John J. Pippenger, Vice President and Director of sales, Double A Products Co., Conference Director .

1) Presentation of awards to winners of HYDRAULICS & PNEUMATICS 1960 Prize Paper Contest by Paul Rolnick, Vice President-Publishing Director, Industrial Publishing Corp., Cleveland.

9:30 A.M. MORNING TECHNICAL SESSION

Chairman: Frank L. Mackin.

1) "Hydraulics in the British Mining Indusrty", J. R. Fawcett, Associate Editor, *Hydraulic Power Transmission,* Morden, Surrey, England.
2) "Hydraulic Filtration Systems," H. C. Zintz, Director of Engineering, The Rucker Co., Oakland.

12:15 P.M. LUNCHEON

2:00-4:30 P.M. AFTERNOON TECHNICAL SESSIONS (all held simultaneously).

Materials Forming Machinery

Chairman: M. G. Sulser and W. H. Bennett.

1) "Standard Module Construction of the Lines of Hydraulic Presses," W. Ernst, Vice President-Director of Engineering, Commonwealth Engineering Co. of Ohio, Dayton.
2) "Extrusion Presses-Today and Tomorrow," A. J. Matteo, Pittsford, N. Y.

Mobile Equipment

Chairmen: V. P. Donner and F. H. Winters.

1) "Steering by Hydrostatics," C. A. Treadwell, Project Engineer, and F. A. Williams, Test Engineer, International Harvester Co. Comments by R. E. Seyfried, LeTourneau-Westinghouse, Peoria, Ill.
2) "Hydraulic Control System for a Track Type Tractor Power Shift Transmission," D. Rohweder, Supervising Engineer of Hydraulic Control Design, Caterpillar Tractor Co., Peoria, Ill. Comments by M. E. Fisher, Supervisor of Hydraulic Component Development, Allison Division, General Motors Corp., Indianapolis.

Servomechanisms and Systems

Chairmen: D. B. Gardiner and M. B. Scherba.

1) "New Techniques in Electrohydraulic System Design," K. D. Garnjost, Corporate Technical Con-

R A M

INDUSTRIAL HYDRAULICS

sultant, and H. B. Kolm, Manager, Industrial Div., Moog Servocontrols, Inc., East Aurora, N.Y.

2) "Pneumatic Servo Steering," J. Harned, Senior Research Engineer, and J. Robertson, Jr., Senior Research Engineer, General Motors Research Laboratory.

Missiles and Space Hydraulics

Chairmen: C. C. Miesse and K. Stehling.

1) "White Room Instrumentation," A. V. Sada, The Weatherhead Co., Cleveland.
2) "Contamination Control in Missile Hydraulic Systems," W. A. Riehl, Redstone Arsenal.
3) "Control of Hydraulic Fluid Contamination," I. R. Walker, Testing Division, Douglas Aircraft Co., Inc., Santa Monica.
4) "Hydraulic Fluid Contamination Sources: Their Recognition and Control," C. B. Davis and G. L. Wenner, The Martin Co., Denver.

5:45 P.M. CONFERENCE SOCIAL HOUR

6:30 P.M. ALL-SOCIETY BANQUET

Speaker: Dr. Curtis L. Wilson, Dean, Missouri School of Mines and Metallurgy, Rolla, Mo., "What of the '60's."

FRIDAY, OCTOBER 21, 1960

9:00-12:00 A.M. MORNING TECHNICAL SESSIONS (all held simultaneously).

Aircraft Systems

Chairmen: R. Davies and R. Bayuk.

1) "Filtration in Aircraft and Missile Systems," H. L. Wheeler, Bendix Filter Div., The Bendix Corp., Madison Heights, Mich.
2) "An Electro-Hydraulic Control Valve for the X-15's Auxiliary Power Unit," W. A. Boothe, General Electric Co., Schenectady.

Automotive

Chairman: F. N. Beauvais and O. E. Hoover.

1) "Recent Advances in Lip Seal Technology," R. L. Dega, Supervisor, Mechanical Development Dept., Research Laboratory, General Motors Technical Center, Warren, Mich.
2) "The Slipper Type Pump for Automotive Hydraulics," H. M. Clark, Manager, Engineering-Hydraulic Products, Thompson Ramo Wooldridge, Inc., Detroit.

Hydraulic Fluids

Chairmen: E. W. Brennan and K. G. Henrikson.

1) "Surgical Cleanliness-Where?," R. Q. Sharpe and K. G. Henrikson, Industrial Technical Div., Products Dept., Socony Mobil Oil Co., Inc., New York.
2) "Hydraulic Bulk Modulus—Its Effect on System Performance and Techniques for Physical Measurement," L. H. Smith, Jr., and L. H. Bernd, General Engineering Laboratory, General Electric Co., Schenectady, and R. L. Peeler, California Research Corp., Richmond Laboratory, Richmond, Calif.
3) "Application of Liquid Metals as Power Transmission Fluids," J. R. Granan and R. C. Kumpitsch, Advanced Mechanical Equipment Engineering, Light Military Electronics Dept., General Electric Co., Schenectady.

12:15 P.M. LUNCHEON

2:00-4:30 P.M. AFTERNOON TECHNICAL SESSIONS (all held simultaneously).

Components and Accessories

Chairmen: J. T. Ellis, Jr., and W. Narcum.

1) "Sealing Devices for Exclusion of Foreign Material From Hydraulic Mechanisms," R. O. Isenbarger, Chief Field Engineer, Chicago Rawhide Manufacturing Co., Chicago.

Machine Tools

Chairmen: F. R. Swanson and P. Rolnick.

1) "Design Analysis of a Two-Axis Electro-Hydraulic Tracer System," L. L. Hill and R. C. Flom, Minneapolis-Honyewell Regulator Co. Panel to discuss paper: R. J. Flanigan, Division Manager, Monarch Machine Tool Co., Dayton; R. K. Sedgwick, Assistant Chief Engineer, Kearney and Trecker Corp., Servo-Machine Tool Div., Milwaukee; Glea Hyland, Hydraulic Engineer, Sunstrand Machine Tool Div., Sundstrand Corp., Belvidere, Ill.; and Ray G. Spencer, Machinery Hydraulics Div., Vickers Incorporated, Detroit.

Pneumatics

Chairman: Z. J. Lansky and A. Huntington.

1) "Analyzing Pneumatic Circuits—It's an Art," G. Riske, Senior Engineer, Hannifin Co., Div. of Parker-Hannifin Corp.
2) "Foundry Air—Its Uses and Abuses," J. L. Yates, Manufacturing Services Dept., Crane Co., Chicago.

Pumps

Chairmen: O. S. Carliss and E. Wiedmann.

1) "A Variable Speed Differential Drive," C. W. Modersohn, Project Engineer, Beloit Iron Works, Beloit, Wisc.
2) "Electrohydraulic Dynamometer and Starter for Laboratory Test Engine," R. L. VanVoorhies, Esso Research Engineering, Linden, N. J., and J. W. Broome, Chief Engineer, Servocontrol Div., The Oilgear Co., Waltham, Mass.

summaries of TECHNICAL PAPERS presented at the 15th NCIH

These abstracts were written by speakers at the NCIH for quick reference. Complete conference proceedings will be published in a bound volume early in 1961.

GENERAL SESSION

HYDRAULICS IN THE BRITISH MINING INDUSTRY

by J. R. Fawcett, Associate Editor, Hydraulic Power Transmission, Morden, Surrey, England.

Hydraulics is used in much of the new equipment being installed in all phases of British mining. Although pneumatics has been used extensively, hydraulics' better efficiency and its suitability for compact machines encourages its use. The breaking of the coal from the face is taking a lesser proportion of mining costs.

The paper explains some of the industry's problems, and outlines a typical layout for longwall working. Hydraulics actuates travel and position of a cutter. It actuates, raises, and advances roof supports. A belt conveyor has hydraulic-motor drive and belt tensioning. In a bunker, hydraulics evens out fluctuations between getting the coal and bringing it to the surface. It is used for underground loading and surface unloading. Stationary systems, below and above ground, will give long periods of trouble-free service if the original design allows for the very difficult operating conditions. Coal face equipment requires systematic servicing facilities.

HYDRAULIC FILTRATION SYSTEMS

by H. C. Zintz, Director of Engineering, The Rucker Co., Oakland.

The paper examines those missile cleanliness requirements related to GSE. Hydraulics actuates the missile's guidance-control package. The hydraulic system must be extremely light and precise. It must have closely-fitted parts. The system demands exceptionally clean fluid. The degree of filtration must be greater than considered practicable until recently.

Contamination occurs during manufacture, testing, and operation. Filtration is the only feasible way to reduce it satisfactorily. The filtration system of GSE for testing and checkout must make itself at least as clean as the missile's system must be, and must remove from the missile's system contamination generated during storage or testing.

The paper discusses some preferred filters, suitable accessory equipment, filtration techniques, and ways to determine cleanliness. It gives current practices and cleanliness standards for some missiles in production.

MATERIALS FORMING MACHINERY

STANDARD MODULE CONSTRUCTION OF THE LINES OF HYDRAULIC PRESSES

by W. Ernst, Vice-President—Director of Engineering, Commonwealth Engineering Co. of Ohio, Dayton.

This paper is about the standardization of a line of single-acting hydraulic presses. The line consists of a series of presses which proceed dimensionally in a preferred number series. Each size has a dual-speed option. Each tonnage group has two ram sizes and six bed options. The presses have conventional power and control systems. 48 presses in each tonnage group require only 15 upright patterns.

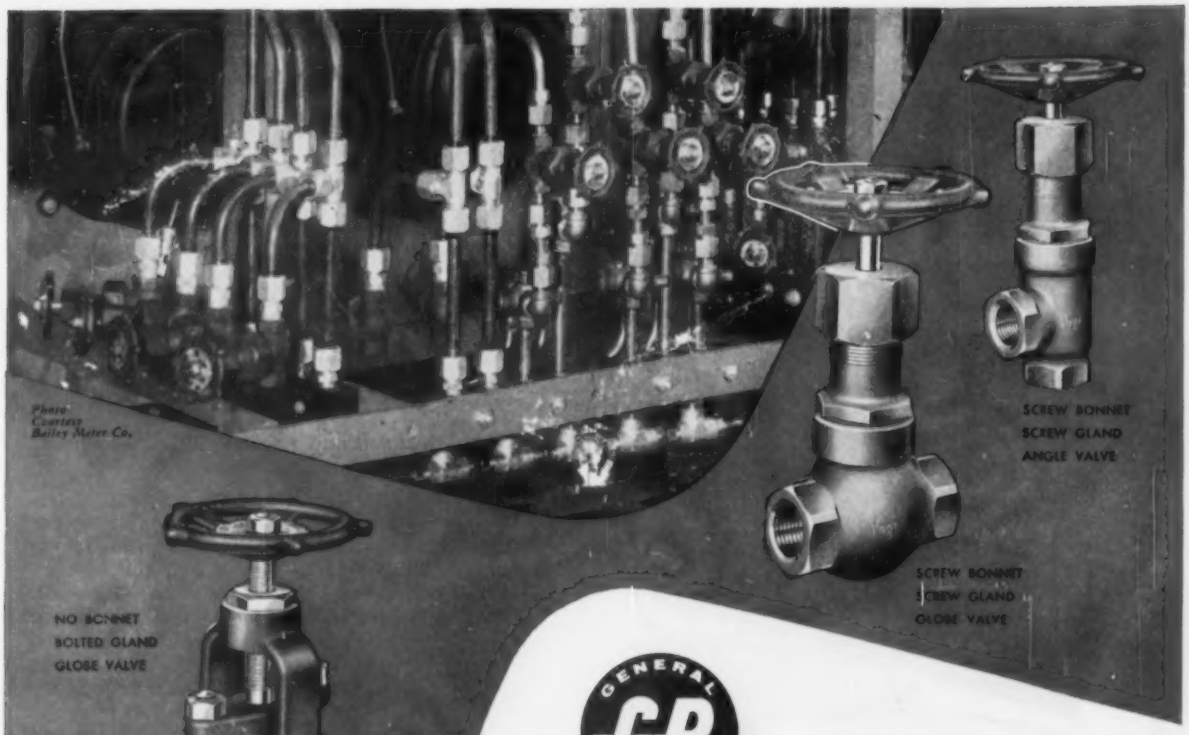
Electric-pilot valves control 2-way reversing pumps. There is no mechanical connection between press and power unit. Three attachments provide multiple-action presses. They can be installed any time. Lift-out cylinders and die cushions use the same standardized mounting. Stroke options match press strokes. Die cushions have rapid-traverse return and optional delayed lift-out. Pulldown rams from the press bed actuate the blankholders. Blankholder force does not add loading to the press frame. The basic press design is not altered. A single-action tonnage group has 576 models. 192 blankholder press models are available.

EXTRUSION PRESSES—TODAY AND TOMORROW

by A. J. de Matteo, Consulting Engineer, Pittsford, N. Y.

This paper is about the limitations of hydraulics in metal-forming equipment. The hydraulic pumps of early, small, self-contained extruders were rated about 150 hp. However, the growing industry demands larger and faster equipment. The 150-hp limitation still exists. The necessary multiple banks of pumps are awkward. The systems need large reservoirs and extensive water cooling. In water hydraulics, little has been done to develop satisfactory equipment. Pumps are still heavy, slow, and expensive. Pumps and valves need high maintenance.

Continued on page 96



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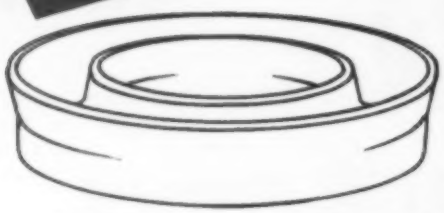

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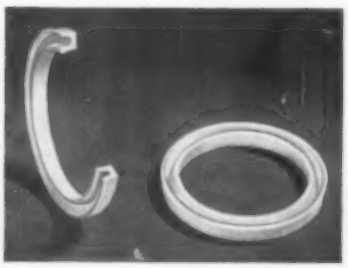

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SUMMARIES OF NCIH PAPERS

The same difficulties confront builders of any other metal-forming equipment. Synthetic, fire-resistant hydraulic fluids are a stop-gap. But are they the answer in a 2000-hp installation? The paper considers the need of the metal-forming industry for water and oil-hydraulic pumps which have high-hp ratings, are compact and reliable.

MOBILE EQUIPMENT

STEERING BY HYDROSTATICS

by C. A. Treadwell and Fred A. Williams, Project Engineers, International Harvester Co.

The 4 x 4, International Harvester's 4-wheel drive, rubber-tired tractor, was designed as a prime mover for large, semi-trailed earth-moving equipment. It was converted to an independent dozing and pushing tractor. A drawbar adapted it for full-trailed equipment.

The steering had to be contained within the tractor. The designers wanted a high-speed machine with the advantages of a crawler tractor—pivot turn, varying rates of turn, and freedom from kickback. For better steering at high speeds, they wanted no loss of power from braking, full power to all wheels, and feathering without full-on or full-off. Other features desired were minimum dependence upon engine speed, ability to steer with a dead engine while moving, and steering with an automotive steering wheel.

The paper reports on the use of a variable-displacement pump and a variable-capacity motor, driving through a cross-shaft to both sides of a planetary differential, to bogie-mounted, rubber-tired wheels.

It covers design of a prototype and the design, building, and field testing of the system. It also covers hydraulics in braking, dozer control, clutch control, and in a hydraulically-operated equipment trailer.

HYDRAULIC CONTROL SYSTEM FOR A TRACK-TYPE TRACTOR POWER SHIFT TRANSMISSION

by D. Rohweder, Supervising Engineer of Hydraulic Control Design, Caterpillar Tractor Co., Engineering Dept., Peoria Plant.

The powershift transmission of the D8 track-type tractor provides more production, simpler operation, better maneuverability, more adaptability to load, faster shifting, less operator fatigue, and greater safety. Its torque divider has the features of a direct-drive machine for such jobs as bulldozing, and the features of a torque-converter for push-loading scrapers. The planetary transmission has three speeds forward and three speeds reverse. A mechanical lockout prevents accidental engagement of the transmission when the operator is not working the tractor. A hydraulic safety feature automatically shifts the transmission control to neutral when the engine is shut off. A modulating relief valve with a sequencing differential valve controls the pressure of the power shift transmission. This provides the shifting characteristics and quality performance required of a transmission of this type used in crawler tractors.

Continued on page 98

HYDROAC

Houdaille announces a new HYDRAULIC ROTARY ACTUATOR

for commercial applications

Houdaille, the world's foremost manufacturer of rotary type hydraulic equipment, now introduces a compact and powerful hydraulic rotary actuator for industrial use. Called HydRoAc, the Houdaille unit is designed to be used in a tremendous variety of applications ranging from turret lathes to farm machinery—from dump trucks to printing presses.

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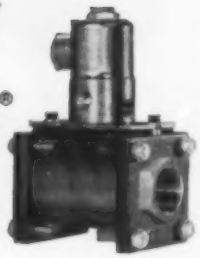

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SERVOMECHANISMS AND SYSTEMS

NEW TECHNIQUES IN ELECTROHYDRAULIC SYSTEM DESIGN

by K. D. Garnjost, Corporate Technical Consultant, and H. B. Kolm, Manager, Industrial Div., Moog Servocontrols, Inc., East Aurora, N. Y.

This paper describes possible industrial uses of new hydraulic servo techniques developed for missiles. One eliminates electrical feedback to improve the reliability of position servomechanisms using hydraulic valve control. Summation occurs at the servovalve pilot stage. Variable-displacement pump stroking and control-valve positioning are discussed as possible applications for high-response mechanical-feedback actuators.

The paper covers means to introduce artificial damping to improve response of resonant systems. Differential load pressure is used as a feedback within the servovalve to approximate load acceleration feedback. Hydraulic-cylinder drives subject to massive loads are possible applications for pressure-feedback valves.

The paper discusses the analytical aspects of the techniques, and their mechanical design and packaging.

PNEUMATIC SERVO STEERING

by John L. Harned and John Robertson, Jr., Senior Research Engineers, General Motors Corp., Research Laboratories.

This paper is about air-power control of vehicle steering. Discussion of the basic requirements leads to a set of system specifications. After the derivation of equations of the system, a parametric evaluation shows critical design parameters. Typical vehicle parameters are used to calculate theoretical responses for steering control and external road disturbances. The paper presents the engineering design of a prototype, and discusses its significance.

MISSILES AND SPACE HYDRAULICS

WHITE ROOM INSTRUMENTATION

by A. V. Sada, The Weatherhead Co., Cleveland.

"White Room" has a variety of meanings, because companies need varying degrees of cleanliness in production assembly. The comparison of the White Room with the established standards of the sciences is erroneous. Through vendor competition or through customer requirement, industry will produce specifications and a way to measure and classify White Rooms.

The problems fall into three categories: those related to precision measurements to check product performance, those related to control of environment, and those related to the psychological problems created

Continued on page 100

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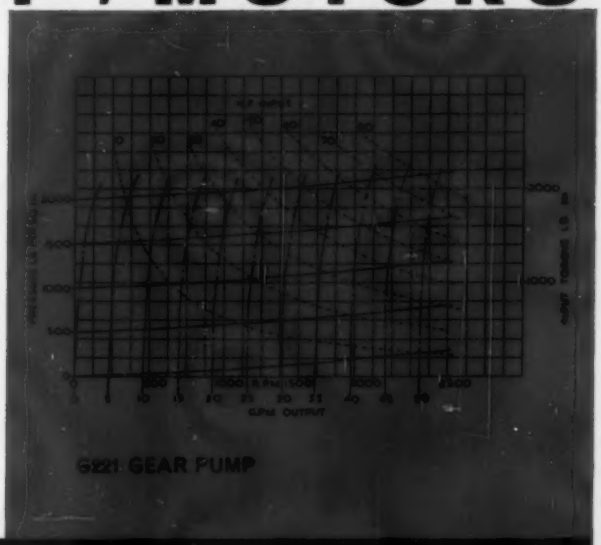

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SUMMARIES OF NCIH PAPERS

by the standards of product-quality assurance and surveillance of personal activities in the area.

The paper evaluates the relative value of a handyman and a highly-skilled technician for the installation, calibration, and maintenance of the facilities.

CONTAMINATION CONTROL IN MISSILE HYDRAULIC SYSTEMS

by W. A. Riehl, Redstone Arsenal

The paper reviews contamination control in hydraulic systems. It divides the subject into the phases of determination, control, and evaluation. In-house methods of determining foreign-particle content provide a satisfactory comparison of fluid cleanliness. But SAE Recommended Practice No. 598 should be employed to determine absolute values or to compare results with those of other laboratories. Laboratories should exchange sealed slides of representative particles, to correlate results. Contamination-control factors which have been investigated recently include clean rooms, system design, filter selection, and cleanliness of the downstream side of filter elements. Representative levels of foreign-particle content attainable by the most experienced laboratories are presented as a guide.

CONTROL OF HYDRAULIC FLUID CONTAMINATION

by D. R. Walker, Testing Div., Douglas Aircraft Co., Santa Monica.

The paper presents problems met in obtaining a super-clean hydraulic fluid. The most critical design parameters of hydraulic systems for testing missile components are type and location of filters and filtering systems, reservoir design, capacity, and accessories, and fittings and packings. Preliminary cleaning and proper training of laboratory personnel reduce built-in dirt in new systems. Fluid sampling is a controversial issue. Is the sample representative? Was there outside contamination during sampling? Final analysis hinges on such parameters as frequency of sampling, time of day, flow rate, type of sampling equipment, location of sampling port, and sampling techniques. Fluid-monitoring methods are a combination of particle counting and visual inspection. Visual comparison can be made with past samples in seconds. The paper discusses recommended time schedules for cleaning and replacing filter elements.

HYDRAULIC FLUID CONTAMINATION SOURCES: THEIR RECOGNITION AND CONTROL

by C. B. Davis and G. L. Wenner, Martin Co., Denver.

The paper presents contamination control theory of missile design and production. The theory is based on experience in the Titan ICBM program. It describes the contamination which causes malfunction in the missile system, its sources, and the devices which control it. One control is a mechanized IBM listing of all parts which require contamination control. The concepts are valid for other fluid systems for which contamination control is a prime requirement.

Continued on page 102

ROTAC

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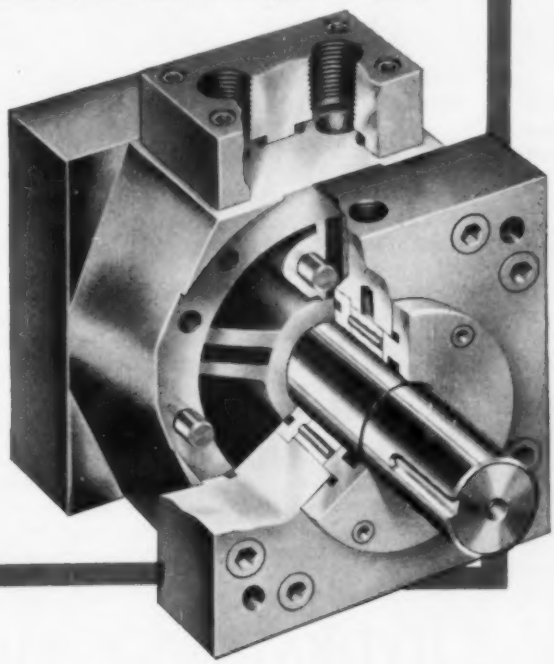

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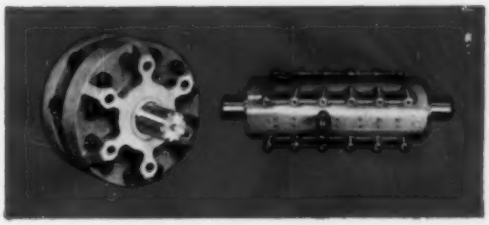

Large illustration shows construction of Model RN (roller bearing) Rotac. Above is a journal bearing type, Model HN. The special Rotac Reciprocating Torque Actuator at right delivers 1,400,000 in./lbs. torque at 1,000 psi.

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AIRCRAFT SYSTEMS

FILTRATION IN AIRCRAFT AND MISSILE SYSTEMS

by H. L. Wheeler, Jr., Bendix Filter Div., Madison Heights, Mich.

Fluid systems of missiles and manned aircraft must handle large amounts of oils, fuels, air, and oxidants, at extremes of temperature and corrosion. As these systems improve, they become more sensitive to contamination. Filter specifications for these systems are becoming more exacting.

This paper is about the requirements and design of the filters. It reviews the types of contamination which might get into the systems. It covers materials application in housings, elements, and seals, in varying environments. Filter cleaning and measurement of contamination are an important part of filter technology.

AN ELECTROHYDRAULIC CONTROL VALVE FOR THE X-15's AUXILIARY POWER UNIT

by W. A. Boothe, General Electric Co., General Engineering Lab., Schenectady.

The APU's which supply in-flight hydraulic and electrical power to the X-15 use high-strength hydrogen peroxide as a fuel. Shaft speed of the turbine-driven units must be held accurately, to keep the frequency of the electrical supply constant. To keep shaft-speed constant, an electrical controller supplies a low-level, electrical-speed-error signal to the peroxide-metering valve.

The paper is about the valve. It must be reliable over a wide range of supply pressure, flow, and temperature. In the analytical phase of design, it was necessary to consider the dynamics of the complete flow-control loop. Limited choice of materials and low force levels possible from the electrical input signal limit the valve's design. The peroxide corrodes most steels, and catalytically decomposes in the presence of many common valve materials.

The valve has two stages and all-poppet design. It has no metal-to-metal sliding contact. The paper describes the precautions which keep the valve free from contamination during manufacture.

AUTOMOTIVE

RECENT ADVANCES IN LIP SEAL TECHNOLOGY

by R. L. Dega, Supervisor, Mechanical Development Dept., Research Lab., General Motors Technical Center, Warren, Mich.

There is a collection of design criteria, from cooperative research and field testing, about almost every mechanical component which has been in use for a number of years. But with lip-type shaft seals, the technology has consisted primarily of cut-and-try methods. General Motors research has provided valuable data on how the interplay of shaft, assembly, and seal enable an application to operate satisfactorily.

Almost all seals corrode shafts by galvanic action. This has been correlated with immediate seal-application failures: product-storage facilities should be a prime consideration. Neutral seal materials will be necessary to improve product reliability. Only cooperative research of seal manufacturers, basic polymer manufacturers, and other associated industries can develop them within a reasonable time.

THE SLIPPER-TYPE PUMP FOR AUTOMOTIVE HYDRAULICS

by H. M. Clark, Mgr., Engineering-Hydraulic Products, Thompson Ramo Wooldridge, Inc., Detroit.

By the use of wide slippers and a novel geometry, the slipper-type pump principle meets many of the requirements of automotive hydraulics. The large area of contact between the wide slipper and the bore reduces stresses, improves sealing, and helps maintain an oil film. This increases mechanical and volumetric efficiency, and lengthens pump life. Because the wide slippers align themselves on the bore, close fitting in the rotor slots for guide or support is unnecessary. The slipper's short radial height permits smaller pumping elements. One pump package can supply two separate circuits—two pumping actions occur simultaneously when the rotor and slippers turn in an eccentric bore. The wide slippers stroking radially in their rotor slots act as pump pistons. The normal, vane-type pumping occurs on the outer side of the rotor between the slippers.

HYDRAULIC FLUIDS

SURGICAL CLEANLINESS—WHERE?

by R. Q. Sharpe and K. G. Hendrikson, Industrial Technical Div., Products Dept., Socony Mobil Oil Co., Inc., New York.

Normal standards of contamination control are not adequate for critical systems which use servomechanisms.

Scale, rust, weld spatters, and metal-machining chips can contaminate a reservoir. Pipe scale and rust preventitives are dangerous in piping. Valves, pumps, and fluid motors may have debris from packing, seals, and sealing compound.

Extreme care must be given to all phases of fluid manufacture, packaging, and transportation. Fluid must be filtered when put into a system. A very pertinent question arises: Because the surgical cleanliness requirement exists only in the machine when it is ready for service, is it not logical to concentrate the principal cleanliness standards at that point, rather than initiate them all the way back at the point of manufacture?

HYDRAULIC-FLUID BULK MODULUS—ITS EFFECT ON SYSTEM PERFORMANCE AND TECHNIQUES FOR PHYSICAL MEASUREMENT

by L. H. Smith, Jr., and L. H. Bernd, General Electric Co., General Engineering Lab., Schenectady,

Continued on page 104

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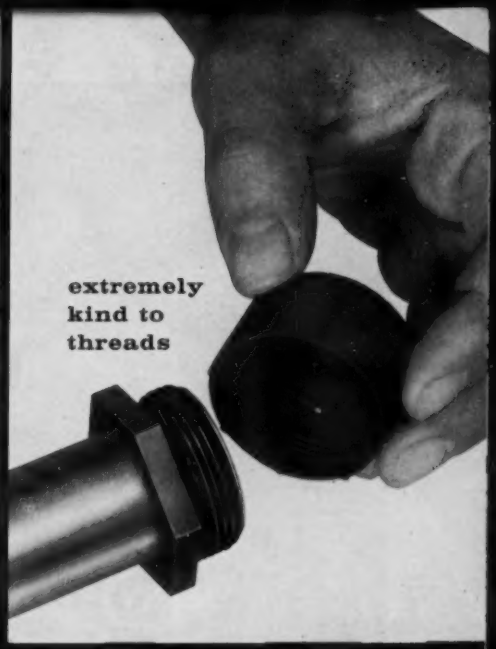

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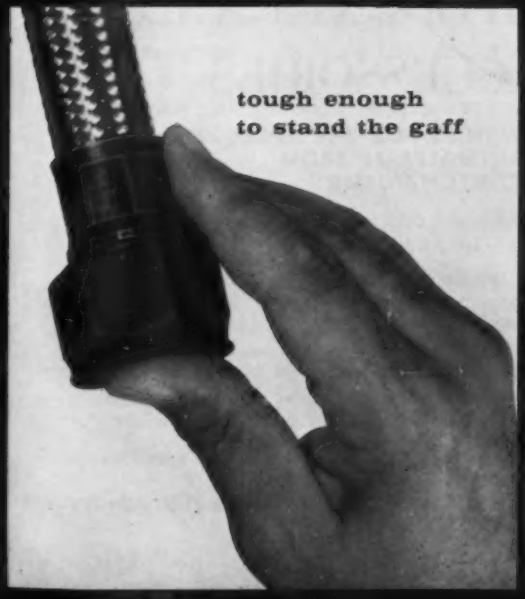

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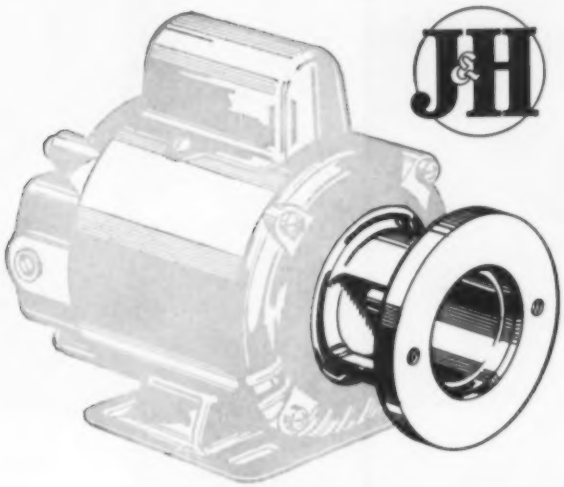

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and R. L. Peeler, California Research Corp., Richmond Lab., Richmond, Calif.

Fluid bulk modulus is the relationship of change in pressure to change in volume. In hydraulics, its greatest effect is on response speed of control systems. It also affects speed of sound in fluid lines, pressure surge, and system stiffness.

This paper cites the effects of fluid bulk modulus on pipe lines, pumps, fluid springs, fluid in injector systems, fluid-power servocontrol systems, lubricants and lubricant systems, liquid gases, and fluid molecular structures. It reviews ways to measure or estimate adiabatic and isothermal bulk modulus. It discusses how chemical composition, temperature, pressure, and mixing affect bulk modulus. It tells how to estimate these effects. These correlations are primarily for pure compounds of low molecular weight. There is a need for methods suitable for the heavier fluids used in industrial systems.

APPLICATION OF LIQUID METALS AS POWER-TRANSMISSION FLUIDS

by J. R. Granan and R. C. Kumpitsch, Advanced Mechanical Equipment Engineering, Light Military Electronics Dept., General Electric Co., Schenectady.

Projected hydraulic-control systems will operate at temperatures over 1000 F. No available synthetic fluid is satisfactory for them. In 1956, General Electric began looking for a suitable liquid metal—one with a low melting point, wide liquidus range, and ready availability. They also considered cost, density, toxicity, and compatibility with other fluids. They selected for testing NaK-77, the eutectic alloy of sodium and potassium. It melts at 9.5 F and boils around 1450 F.

To test it, a low-pressure loop stores, heats, and cleans the metal. A pump supplies a constant flow of 1 gpm at 3000 psi, 1000 F. A mechanical-input hydraulic servo is used to study the dynamic behavior of NaK-77 in servovalves and actuators. The design uses titanium alloys and carbides. Gears, shafts, valves, and pistons were machined from solid tungsten and titanium carbides. Hydrostatic bearings offset the poor lubricity of liquid metals.

COMPONENTS AND ACCESSORIES

SEALING DEVICES FOR THE EXCLUSION OF FOREIGN MATERIAL FROM HYDRAULIC MECHANISMS

by R. O. Isenbarger, Chief Field Engineer, Chicago Rawhide Mfg. Co., Chicago.

Inadequate exclusion sealing can cause contaminated hydraulic fluid, clogged valves and lines, and corroded and worn parts. In the literature on sealing devices, little emphasis is given to exclusion sealing.

The designer must consider operational conditions. Most important are the kind of motion, and the material to be excluded. Axial and radial exclusion seals are

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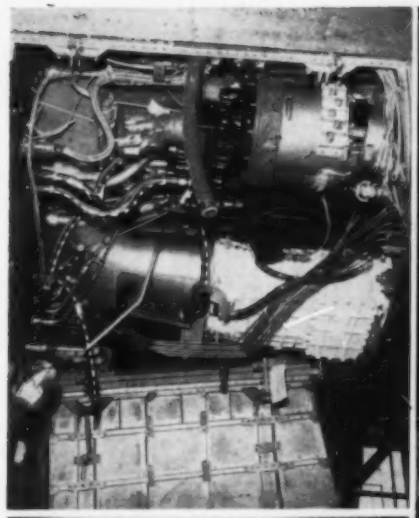

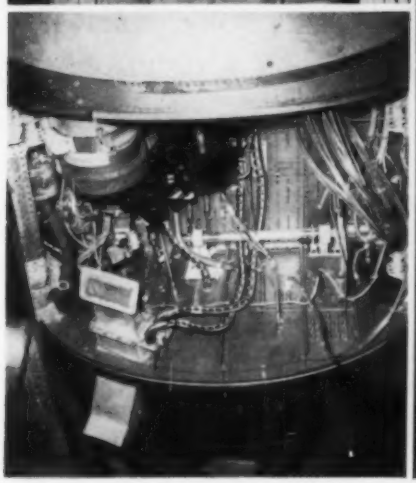

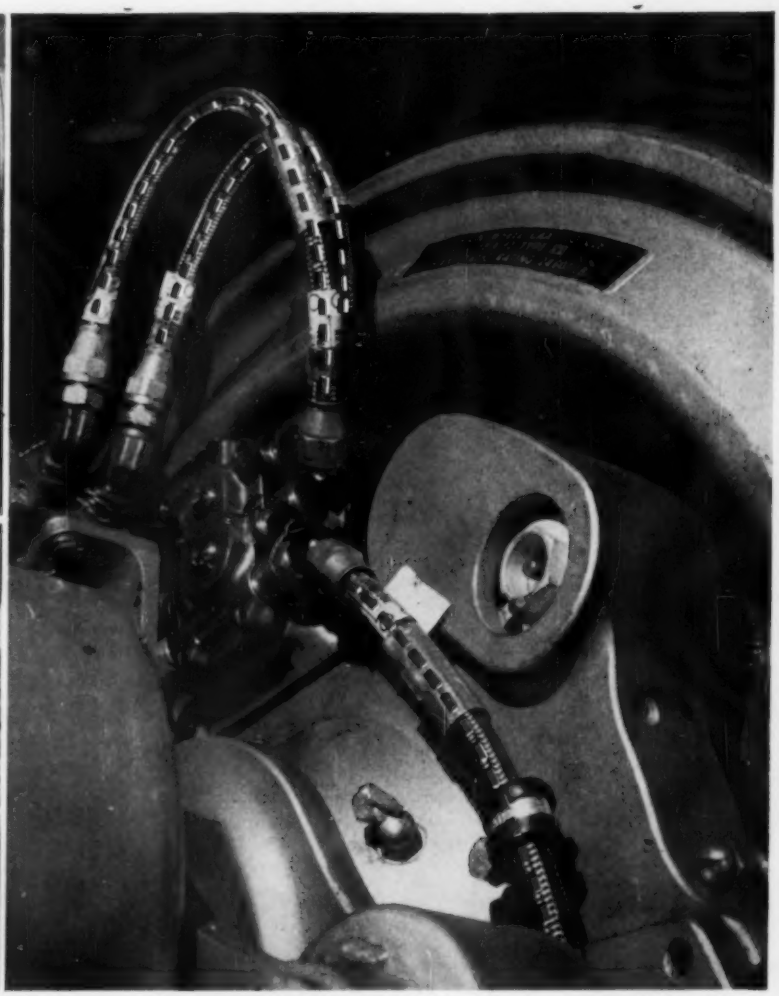

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used for rotating shafts. Wipers, scrapers, boots, and diaphragms protect reciprocating shafts. Construction varies from simple, one-piece members to fabricated seals of two or more parts or materials. Some seals have inclusion and exclusion functions. Proper choice and use of an exclusion seal can make a hydraulic mechanism less expensive, more efficient, and longer lasting.

MACHINE TOOLS

DESIGN ANALYSIS OF A TWO-AXIS ELECTROHYDRAULIC TRACER SYSTEM

by L. L. Hill and R. C. Flom, Design Supervisors, Minneapolis-Honeywell Regulator Co.

The paper presents the design and testing procedure for an electrohydraulic tracer system applied to a vertical milling machine. The x and y-axes are under continuous contour-following control. The z-axis is under position and/or single-axis tracer control. The paper discusses performance specifications for the machine, and the corresponding requirements of the tracer system.

Once the system's overall functions are understood, the performance requirements are transposed into static and dynamic servosystem requirements. The paper covers initial machine tests for determining friction, stiction, inertia, and mechanical resonances, and the limitations which the machine and control system impose upon accuracy and frequency response. Problems discussed are oil contamination, effect of pressure drop on linearity, backlash, and mechanical or hydraulic resonances. Presentation of procedures and results on a breadboard system precedes a discussion of design improvements.

PNEUMATICS

ANALYZING PNEUMATIC CIRCUITS—IT'S AN ART

by G. Riske, Senior Engineer, Hannifin Co., Div. Parker-Hannifin Corp.

- **Gathering the Component Data**—The great variety of capacity-rating methods make it difficult to define component flow restrictions in pneumatic-circuitry analysis. A method well-adapted to capacity-rating conversions is an extension of a valve-rating procedure proposed by the National Bureau of Standards in a recent SAE paper.

- **Define the System Limits**—A pneumatic circuit begins at the compressor receiver tank, and ends at the exhaust port. This definition avoids the pitfalls of analyzing only a part of the circuit on the assumption that the other parts don't affect it.

- **Effect of Component Location**—The general analysis of a pneumatic system is made without regard to component sequence. However, the flow factors are combined to provide the lowest maximum flow conditions expected at the critical pressure loss. Other flow se-

Continued on page 108

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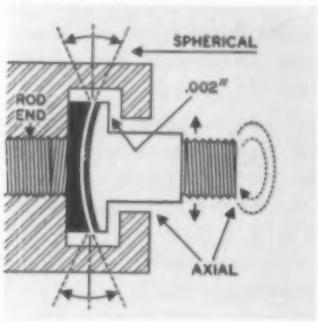

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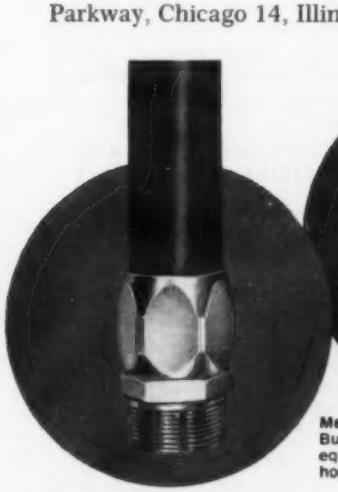

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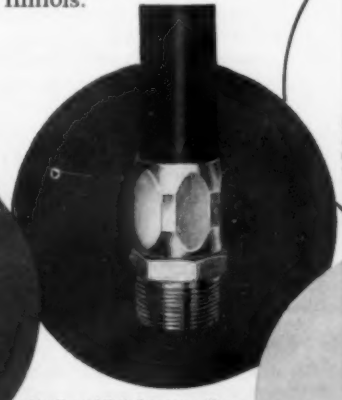
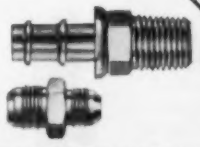


Medium High Pressure Hose. Burst and working pressure equivalent to SAE 100R1. In hose ID's from ⅜" to 1¹³⁄₁₆".



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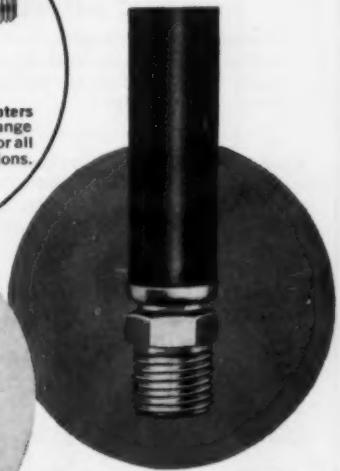

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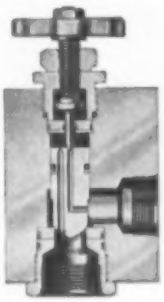

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SUMMARIES OF NCIH PAPERS

quences through the same components may permit flow rates 10% higher than calculated.

FOUNDRY AIR—ITS USES AND ABUSES

by J. L. Yates, Chief Project Engineer, Crane Co., Chicago Div.

This paper is about the air-handling problems of maintenance men in steel, iron, and brass foundries. Air unloads and transports bulk material. Abrasion makes ordinary metals and devices unsatisfactory. The air which supports combustion in iron foundries has considerable influence on product quality and cost. In some molding systems, variation of airline pressure affects mold hardness. Air which blows sand into cores and molds must be valved and vented so that the sand density in the finished piece is uniform. Air-control devices for automatic molding must be reliable. Air tools present a growing group of maintenance problems, but they accelerate production. The paper tells what can be done, and outlines basic ideas for future controls of air-driven equipment.

PUMPS

A VARIABLE-SPEED DIFFERENTIAL DRIVE

by C. W. Modersohn, Project Engineer, Beloit Iron Works, Beloit, Wisc.

This paper is about mechanical-hydraulic drives for sectional machines which manufacture continuous web or filimentary products. Accurate, flexible speed control between sections keeps product tolerances close, and cost low. A common lineshaft supplies a group of differentials. In each section, a hydraulic drive supplies the variable portion of speed and torque. The drive is designed for the section's power level, and for the necessary range of speed variation between the section and adjacent sections. Control of individual drives is highly accurate, and section-to-section variation is correspondingly narrow. The line-shaft powers the hydraulic portion. Electronic control of pump displacement gives the advantages of remote adjustment from a central point. A closed-loop, hydraulic servo circuit provides speed and accuracy. Added controls protect against overload and simultaneously adjust speed of all stands in geometric progression toward the exit.

ELECTROHYDRAULIC DYNAMOMETER AND STARTER FOR LABORATORY TEST ENGINE

by R. L. VanVoorhies, Senior Research Eng., Esso Research & Engineering Co., Linden, N. J., and J. W. Broome, Chief Eng., Servocontrol Div., The Oilgear Co., Waltham, Mass.

The paper is about an electrohydraulic system which starts a lab test engine, supplies a variable load to the engine, and maintains a constant engine speed. The laboratory tests fuels, lubricants, etc. The life of the measuring instruments and control equipment must be many times that of the duration of the test. Safety devices allow the machine to operate unattended. If a critical part of the system fails, the trouble is automatically corrected, or the equipment shuts down and preserve the data. The system adapts to an automatic data-logging system, which provides continuously-computed and displayed data.

Hydraulics & Pneumatics

October 1960

AIRCRAFT SECTION

MISSILES • SPACE VEHICLES • GROUND SUPPORT

COMPRESSED AIR SITS IN FOR EXPLOSIVE CHARGE 110

By C. Phillip Strakosch

Ejection seat simulator gives trainees the feel of ejection acceleration. Calculations are given for sizing the air cylinder and air storage tanks to achieve 1.7 g's with 100 psi.

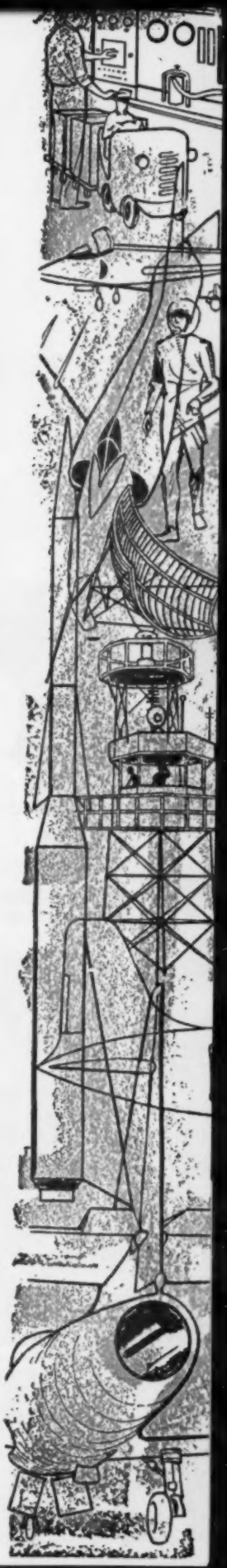
PACKAGED SYSTEMS—NEXT STEP FOR HYDRAULICS 112

By Henry Lefer

New York Air Brake's three-day technical meeting at Watertown presented material on aircraft and industrial fluid power. Papers discussed modular hydraulics, integrated power systems, missile train pneumatic braking systems, and system cleanliness.

AVIATION NEWS FROM THE FLUID POWER FIELD 122

AIRCRAFT COMPONENT DATA 124



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Compressed air sits

• By C. PHILLIP STRAKOSCH,

Quick release of 100-psi air propels this training ejection seat and simulates acceleration produced by an explosive charge during actual ejection. Pneumatic simulation is safer and more flexible.

THIS pneumatic ejection seat simulator familiarizes jet aircraft crew members with the feel of acceleration due to ejection, and trains them in procedures for ejection. In place of an explosive charge, compressed air is used as a safe and easily controlled means of duplicating expanding propellant gases used in in-flight ejection. On an actuating signal, a charge of compressed air is released. The expanding air enters the catapult cylinder propelling the ejection seat upward.

• **Acceleration Is 1.7 g's**—Air provides a pneumatic "detonation" with characteristics similar to chemical detonation: a peak, initial pulse force of about 1.7 g's followed by decreasing acceleration. The simulated forces are much less than the true ejection forces which are very high and for emergency action only.

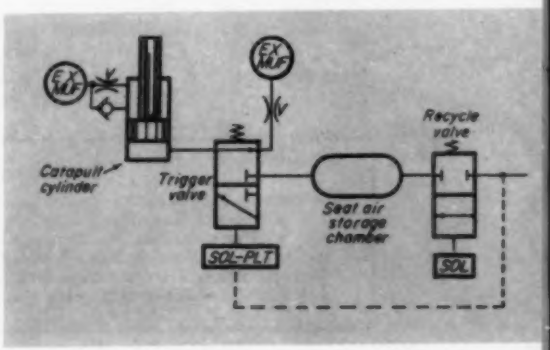
A 250-lb man (including equipment) sitting in the simulator's 40-lb bucket seat is propelled 48 inches upward. This is enough to give the feel of actual ejection. It is also far enough to check whether the trainee was in proper position to avoid striking nearby aircraft parts.

A 100-psi charge of compressed air is admitted to the seat air chamber and then isolated from the primary air supply system by the re-cycle valve. Air in the seat chamber is then expanded suddenly into the catapult cylinder through a quick acting, large ported trigger valve. As the air charge expands, its pressure drops. The system is designed so that terminal pressure is just enough to bring the ejection seat and trainee to the up position where it is mechanically latched in place.

• **Sizing Storage Tanks**—The primary air supply tank has sufficient capacity to supply air for 10 complete cycles. It was sized by calculating the free air volume for 10 ejection cycles and relating that volume to a selected tank pressure. But first the seat chamber must be sized from the following information:

Weight of trainee
including equipment . . 250 lb

PROPELLED UPWARD 48 inches by expanding compressed air in the catapult cylinder, a trainee in the ejection seat simulator undergoes 1.7 g's acceleration. This pneumatic "detonation" simulates the forces on a crew member when he is ejected during actual flight.



in for explosive charge

Project Engineer, The De Florez Co., Englewood Cliffs, N. J.

Weight of ejection seat ....40 lb
Weight of piston
and piston rod .....10 lb
Piston stroke .....48 in
Piston diameter .....3 in
Piston area .....7.07 sq in
Operating pressure .....100 psi

Total load is 300 lb. Air pressure required to balance this 300-lb load with a 3-in cylinder is 42.5 psi. For the 48-in stroke, catapult cylinder volume is 0.196 cu ft.

• **Seat Chamber Volume**—We apply the following equation to find the volume of the seat chamber. Its initial 100-psi air charge must be just enough, after expansion into the cylinder, to obtain 42.5 psi in the cylinder-chamber system. Expansion is assumed to occur adiabatically since only slight heat is transferred during rapid expansion. Adiabatic expansion is expressed by:

$$P_1V_1^k = P_2V_2^k$$

Substituting actual data into the equation and changing to absolute pressure:

$$114.7\ (V_{100})^{1.40} = 57.2\ (V_{100} + 0.196 + 0.068)^{1.40}$$

k is the specific heat ratio for air. 0.068 cu ft is the volume required by valving and air lines.

V_{100} = 0.408 cu ft, seat chamber volume

• **Seat Chamber Not Exhausted**—After the trigger valve closes, air in the catapult cylinder and lines only exhausts to atmosphere. Air at 42.5 psi remains in the seat chamber. So energy is saved because the seat chamber is recharged to 100 psi from 42.5 psi and not from atmosphere. To size the primary air supply tank, we calculated the volume of free air consumed for each ejection. Volume of free air consumed is the volume of free air in the storage chamber before ejection minus the volume of free air after ejection. This is calculated by:

$$0.408\left(\frac{114.7}{14.7}\right) - 0.408\left(\frac{57.2}{14.7}\right) = 1.59 \text{ cu ft}$$

• **Sizing Supply Tank**—Ten ejection cycles consume 15.9 cu ft of free air. The size of the primary air supply tank depends on initial pressure in the tank before starting the ten ejections. To provide air for the tenth ejection, air pressure in the tank must be slightly above 100 psi. The tank must be big enough to supply 15.9 cu ft of free air which is the difference between the tank's volume of free air at initial pressure and the volume of free air at 100 psi.

$$15.9 = V\left(\frac{P + 14.7}{14.7}\right) - V\left(\frac{114.7}{14.7}\right)$$

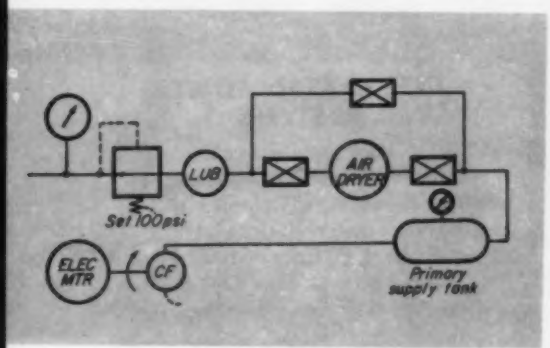
$$V = \frac{234}{P - 100}$$

where:

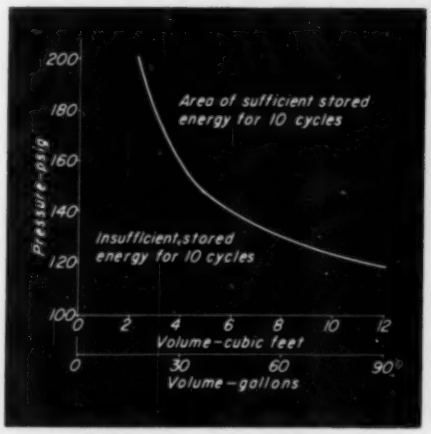
V = primary supply tank volume, cu ft
P = initial pressure, psi

The equation's pressure-volume relationship is shown on the graph. A commercially available compressor and supply tank were selected.

• **System Flexibility**—An advantage of using pneumatic power is that system values are readily adjusted to achieve different results. The numerical values indicated in the calculations are typical values only. For example, if the seat air chamber pressure were increased to obtain higher acceleration forces, the chamber volume would have to be reduced to keep the same terminal pressure. ▼▼▼



TRIGGER VALVE SUDDENLY RELEASES 100-psi air from the seat air chamber to the catapult cylinder. Reducing valve lowers the air pressure from the primary supply tank to 100 psi for initial actuation of the seat. Final cylinder pressure is 42.5 psi which just supports load.



PRESSURE-VOLUME RELATIONSHIP determines the size of the primary air supply tank. A smaller tank needs a higher pressure to store the same volume of free air.

Packaged systems —next step for hydraulics

• By **HENRY LEFER**, *Eastern Editor*

Integrating components—pumps, valves, reservoirs, and lines—into a single housing has been one of the aircraft designer's answers to the need for high reliability in limited space. That we'll see more of this packaging in future designs was shown by papers and discussion at the symposium held recently by New York Air Brake Co.

PREPARED papers delivered by guests and NYAB personnel, and discussions from the floor covered such areas as modular design of aircraft hydraulic components, hydraulic starting systems, and integrated hydraulic/electric power systems, as well as problems dealing with hydraulic system cleanliness and hydraulic vendor performance.

MODULAR HYDRAULICS

Grady Gilder, Project Engineer, Chance Vought Aircraft, Inc., reported on Project Hydratoy, a program aimed at the development of integrated systems, composed of standard modules assembled into manifolds or packages, to perform particular functions. These modular systems would be lighter and smaller than conventional systems, would require minimum amounts of tubing and fittings, and would be far more reliable.

The program, which is being conducted under contract with the Airborne Equipment Section of Navy's Bureau of Weapons, has led to the development of a series of standardized internal cartridges for all types of components required in hydraulic system design (check valves, relief valves, shuttle valves, etc.). CVA's job has been to determine the feasibility of the approach, develop specifications for the cartridges, and run qualification tests on items developed for the program by components manufacturers.

Gilder cautions that there will be a price to pay for the advantages of the modular approach. For example:

- More design time and effort will be required to bring a system from concept to production. This will be even worse if pre-tested standard cartridge components are not available.
- The design will be somewhat inflexible once set. It won't be as easy as before to wait until the actual vehicle system is operating to solve minor problems. System tests will have to be simulated and proven long before final system fabrication.
- Initial cost will be high, mainly because of the greater expenditure of time and effort. But this higher price will buy a highly reliable and easily serviced system.

AIRCRAFT AND INDUSTRIAL FLUID POWER was the subject of technical papers presented. Here, from left to right are E. V. Manning, Chief Engineer, Aircraft Equipment Section, New York Air Brake Co., E. G. Emery, Jr., Pratt & Whitney Aircraft Div., United Aircraft, D. K. Breaux, Project Engineer, AiResearch Mfg. Co., Division of Garrett Corp., and J. Tinius, Sr. Project Engineer, NYAB, Watertown Div.

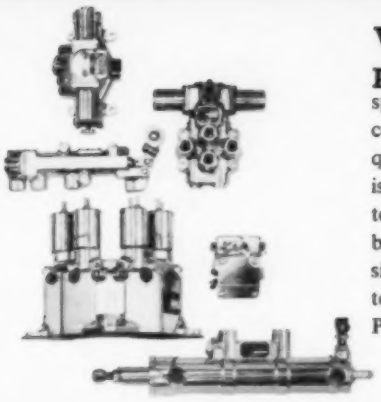
INTEGRATED POWER SYSTEMS

The same type of thinking that leads to modular components is also shown in the approach to integrated power systems.

Richard P. Cuny, Group Project Engineer at Avco Corp.'s Lycoming Division, described his

Continued on page 116

Circle 5 ➔



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company's work in developing an integrated hydraulic and electrical power and starting system for a high-performance drone.

Until a few years ago, Lycoming's experience was that an airframe manufacturer would issue specifications and request quotations from vendors specializing in individual components. Thus, each component was designed to and qualified to its own specification and handled as a separate entity by its particular vendor. The airframe manufacturer was responsible for system management and coordination.

In recent years, the trend has been toward the procuring of the entire power system from one of the component manufacturers—usually the one who makes the drive or generator. Among the advantages seen for this method:

- Qualification is accomplished on the complete system.
- Elimination of overlapping tests cuts cost of qualification testing.
- Airframe manufacturer receives a "component-compatible system" (i.e., it works).
- The vendor responsible for the system is free to match and marry individual components, combining functions, such as structural members, bearings, and cooling systems, to get the best results out of his building blocks.
- Lead time is cut, as the bugs that might develop between components have already been eliminated by the time the system is delivered to the airframe manufacturer.

HYDRAULIC STARTING SYSTEMS

Ed Manning, NYAB's Chief Engineer—Aircraft Equipment, described his company's progress in this area.

Hydraulic starting systems for missiles and aircraft offer major savings in size and weight, particularly if the design incorporates a single hydraulic system to start the engine and supply prime hydraulic power. The pump that supplies hydraulic power to the engine starter becomes a hydraulic motor once the engine has started.

Dual-purpose hydraulic designs such as this make it feasible to build self-contained starting into aircraft, doing away with the need for ground or shipboard support equipment for this purpose. The system is particularly effective on multi-engine aircraft where an auxiliary motor-pump unit or hydraulic motor-driven generator is already required for other purposes.

Other system considerations—such as flow and torque requirements—will dictate whether the hydraulic starting should be a separate system or integrated in the aircraft's hydraulic pumping system.

One NYAB system, developed for the Navy version of the Sikorsky S-61 helicopter, utilizing an APU in combination with an accumulator to drive the starter pumps on the T-58 engines, is self-contained and separate (although a simple change can integrate it in the copter's hydraulic system).

A system for smaller engines, such as the T-53, is designed as an integral part of the hydraulic system. It uses stored hydraulic energy (accumulators) as the sole source of power for engine starting.

Among the potential advantages that hydraulic starter or starter pump systems offer the designer:

- Weight reduction, through integration of starting and pumping systems.
- Elimination of one accessory pad and gear train per engine.
- Lower installed and spares cost.
- Simpler servicing and maintenance.
- System that is mechanically able to give unlimited continuous engine cranking with the help of the ground power supply, without damage or overheating.
- If the system has an accumulator and handpump for an initial energy source, it has recharge capabilities not possible with other forms of energy.
- Lower maximum torques at the engine pad for equal time to starter cut-off speed.
- Lower operating speeds and temperatures of bearings, gearing and clutches, for equivalent power output.

MISSILE TRAIN PNEUMATIC BRAKING SYSTEM

H. N. Sudduth, NYAB's Chief Engineer—Railway and Pneuma-

tic Equipment, delivered this paper.

Railroad trains will provide roving launching sites for the Minuteman missile. Typical trains, consisting of from 13 to 17 cars, will have to be capable of being hauled by whatever type of road locomotive is standard for and available on any of the railroads in their assigned territories. They will have to withstand a wide variety of environmental and operating conditions, without their systems freezing up or burning out.

A typical train will weigh close to 3.5 million lb, with individual cars weighing from 120,000 lb (on 2 four-wheel trucks) to 275,000 lb (on 2 six-wheel trucks). It will have to accelerate and decelerate smoothly at speeds up to 60 mph.

Kinetic energy must be converted into heat at rates up to 38,000 hp. This is done through pneumatics, and requires less than 6 ft-lb work to manipulate the brake valve.

The system is fail-safe. Anything causing a reduction in the pressure in the trainline—intentional or otherwise—is interpreted by the control valve as a brake-applying signal, and air is immediately released from the reservoir into the cylinder locally in each car.

DYNAPOWER HYDROSTATIC TRANSMISSION

Papers by Karl W. Galliger, NYAB's Manager of Engineering, and W. T. Stephens, Manager of Hydraulic Equipment at J. I. Case Co., discussed progress and possibilities of hydrostatic power units.

NYAB's hydrostatic drive—the company calls it the Dynapower transmission—consists of a hydraulic pump (driven by the engine or prime mover), a hydraulic motor (which drives the wheels or other power-receiving devices), an integrated control valve incorporating relief and check features, and appropriate tubing. The pump and motor are typical NYAB designs—axial piston type with ro-

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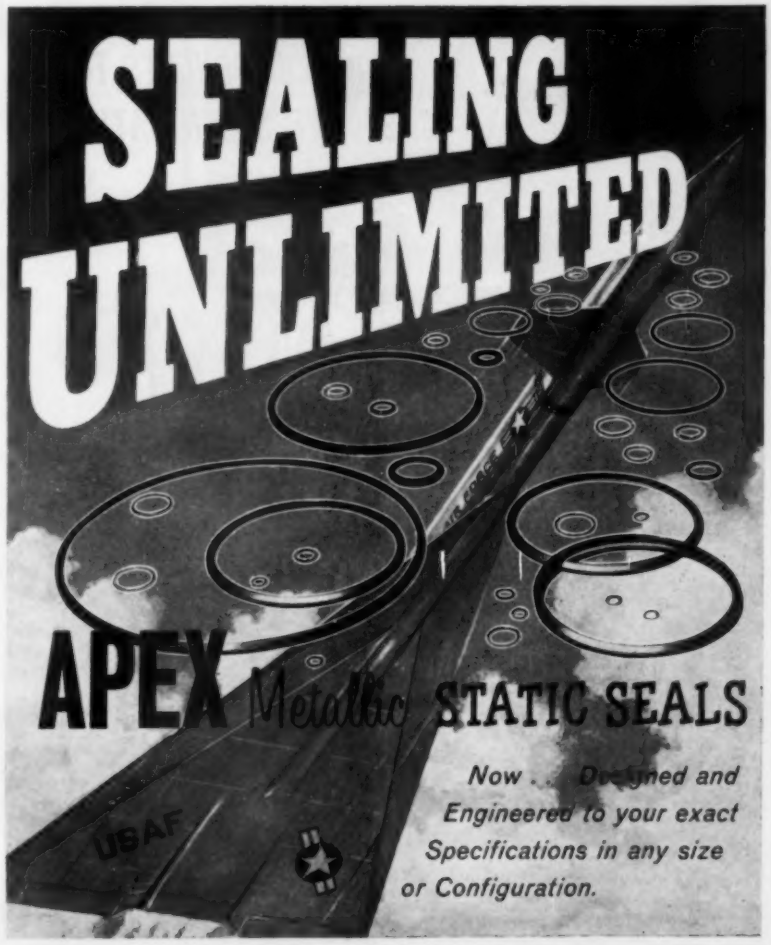

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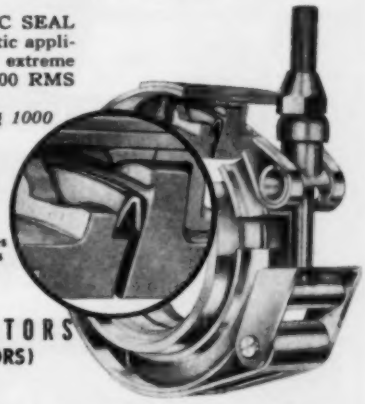

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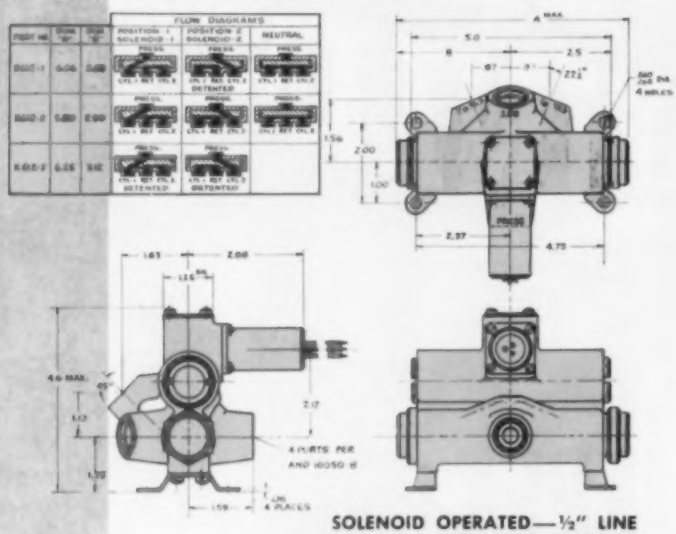

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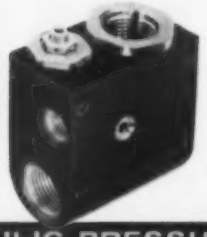

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tating cylinder block and employing either overcenter variable displacement (by means of a variable cam) or fixed displacement construction, depending on system requirements. Design pressure is 3000 psi.

In a hypothetical vehicle application, the variable displacement pump might be coupled directly to the engine driveshaft, and a fixed displacement motor coupled to the differential. When the engine is started, the pump turns over but does not move any fluid, as the variable cam is in neutral and the pistons are not displaced. Since no fluid is pumped to the motor, it does not turn.

But when the control is pushed to forward, the cam tilts, causing the pump to force hydraulic fluid to the motor. Since oil is incompressible, the motor must respond, driving the vehicle's wheels through the differential.

The drive is smooth and positive, responds instantly to the control, and exerts the maximum amount of pressure or torque within the capacity of the mechanism regardless of speed or load. In snow or mud, or on ice, the wheels will not spin for lack of traction to take up their energy; they will turn as slowly as the pump output will direct them to, and deliver full power. Even at engine idle speed, the transmission delivers full power, with no stalling and no slipping.

The hydrostatic transmission also provides full dynamic braking; that is, the inertia of the engine is transmitted through the "rigid" hydraulic system to the hydraulic motor and differential to slow the vehicle when power is removed.

Performance of the Dynapower transmission was demonstrated at the Technical Symposium on a test Yale and Towne forklift truck equipped with the NYAB drive. This is one of six experimental installations that NYAB has in the field.

The Y&T vehicle demonstrated its ability to get through terrain that stopped trucks fitted with

Continued on page 120

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HYDRAULIC ENGINEERING FOR INDUSTRY

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Model 0321

Model 0521

GAST rotary vane AIR PUMPS

— Vacuum or Pressure —

- **Four sizes—Built-in motors**
- **Compact, portable, reliable**
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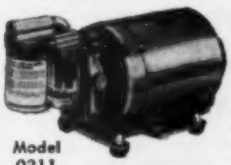
To reduce weight, save space and cut costs—use Gast Integral-Motor-Pump Models! Fitted for vacuum—or as air compressors. For oil-free air, some offered with oil-less construction. Very compact and dependable. Positive displacement.
Used as original equipment on instruments, test units, etc. Capacity from ½ to 3.8 cfm; to 28" vacuum or to 25 psi.



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Model 0406

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• AIR MOTORS TO ½ H.P.
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"Air may be your answer!"

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Rx The RECOMMENDED PRESCRIPTION for CURING MOISTURE...DIRT and LUBRICATION PROBLEMS in COMPRESSED AIR LINES

Arrow

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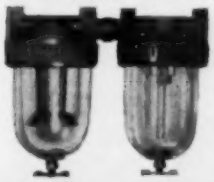
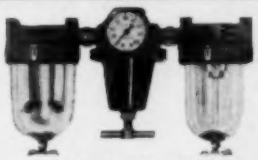


FILTERS

LUBRICATORS



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Pipe Line Sizes ¼"—⅜"—½"—¾" and 1"

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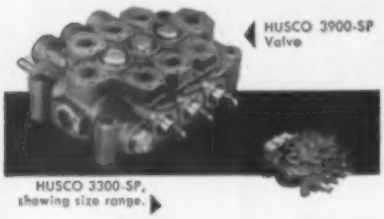
Why **HUSCO HYDRAULIC MULTI-PLUNGER VALVES** *fit a greater range of control needs . . .*



HUSCO 3300-SP, showing size range.

- **Choice of FIVE Basic Model Sizes — over 120 standard valves for unlimited modifications to specific needs.**
- **Control up to SIX Cylinders, single or double acting.**
- **Up to FOUR Standard Control Positions — raise, lower, float and neutral.**
- **Available with Flange or Standard Mounting (3900 Valves only).**
- **Accurately Rated Capacities from 3 to 185 G.P.M. at 22 f.p.s. velocity.**

These are only a few reasons why HUSCO Valves are more flexible in adaptation to your needs, more efficient in power-saving control.

Write for detailed specifications on HUSCO 3300-SP and complete catalog "Husco's House of Ideas" — or engineering aid on your hydraulic control needs.

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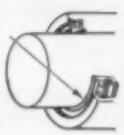
ROY BOBBS AIR-DRAULIC CO., Portland, Ore.

Fall . . . *the original*
SPRING-LOADED
Wiper **Ring**

This patented closed joint ring provides squeeze - grip action, assuring complete contact on the rod at all times. Maintains uniform, continuous pressure on wiper edge. Rods are always clean in any temperatures.



Fall "CJ" Wiper Rings operate most effectively under extreme conditions of dust, glaze, oil, grit, powder, gases, sand, ice, etc. Available in diameters ½" through 13". For any commercial use. Used by military and aviation industry since 1944.

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PACKAGED SYSTEMS

other types of drives. It went up and down ramps, over humps and obstructions, raising and lowering forks as it ran, all with no change of speed except when the operator called for it, showing the drive's ability to control wheel speed precisely regardless of load.

The other test installations:

- A dual transmission system on an agricultural tractor includes a pump/motor package for each drive wheel, giving the vehicle exceptionally good maneuverability and terrain performance.
- Power steering for a large road scraper machine. The manufacturer had formerly used a constant flow hydraulic system for steering, but this is inefficient, wasting power when only a small flow is needed. The hydrostatic system pumps only the fluid needed for the task.
- A concrete mixing truck's drum drive. This application is being tested by a chain drive manufacturer.
- A self-propelled combine drive is being tested by a major manufacturer of heavy farm machinery.
- The Army is testing Dynapower transmissions at Ft. Belvoir in an undisclosed application, thought to be all-terrain vehicle.

NYAB has made its Dynapower pumps and motors of the same size and with a large number of parts interchangeable, to keep costs down. An extensive endurance program on the power units and valves is continuing, to insure reliability.

The size on which most of the development has been done is the 4.5 cu. in./rev. unit (nominal rating 60 hp at 2000 rpm), but work is proceeding both on larger and smaller sizes.

SYSTEM CLEANLINESS

Isn't the demand for "surgically clean oil" in our hydraulic systems carrying us too far? This question was asked by the civilian representative of one of the military services.

There is too much downtime involved in the maintenance of such clean systems, he said, suggesting that we might either have to change our design thinking and aim for dirt-tolerant systems, or come up with simple go-no-go indications for system cleanliness.

The speaker cited one of the Air Force's first-line planes as an example of the difficulty and time involved in keeping hydraulic systems at required cleanliness in the field. The mechanic for this plane has a kit, including a hypodermic needle, filter patches, microscope, and photos illustrating degrees of cleanliness. He draws oil samples from designated points in the system, tests them on filter patches, and compares their appearance with four photos, labeled *clean, slightly dirty, very dirty, and extremely dirty.*

The first two conditions are acceptable, the last two are not. The extreme conditions—clean and extremely dirty—are fairly easy to determine, but the two middle ones are often tough to differentiate. Under these circumstances, whether to label a sample slightly dirty and pass it, or very dirty and connect the system to a filter bank and recirculate the oil until it passes the test is probably the type of exercise of judgment which should not be forced on a mechanic.

VENDOR PROBLEMS

Life is made difficult for the aircraft people by the troublesome practices of some vendors of hydraulic components, the representative of a major airframe maker complained. As a result, his company insists on seeing and checking vendors' detail drawings. Vendors don't like this, but they bring it on themselves. Among the complaints:

- Vendors cumulative tolerances don't add up to totals of individual tolerances.
- Packings or O-rings are not supported and they may be shredded by sharp edges and corners during placement.
- Springs are unsupported and buckle or bottom, sometimes blocking hydraulic passages.
- Improper hardware, such as nuts or bolts, is used for assembly.
- No provision is made for locking threaded parts.
- Bosses for fitting connectors are poorly designed, permitting fittings to be inserted too far, causing malfunction. ▼▼▼

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LOCK OUT AIR FOR MACHINE REPAIR

Ross

Locks
Out and
e**X**hausts
VALVE

Lock out air that operates a machine, as a safeguard when making machine repairs. The Ross L-O-X Valve installs in the supply line leading to the machine, upstream of any operating valve. Designed so that when closed, supply-air to the machine is shut off and air downstream is exhausted. Can be padlocked in this position.

More L-O-X valves can be incorporated in the circuit to shut off and exhaust various segments of the circuit. Detented open; very low pressure drop; Lightweight aluminum construction. Call your Ross representative or write for literature.

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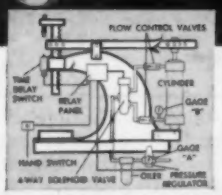
AUTOMATION TIME DELAY SWITCH

FOR CONTROLLED TIME DWELL OF AIR OR HYDRAULIC CYLINDERS



Arbor press converted to high production power press, using double end cylinder, Time Delay Switch, Flow Control Valves, and related equipment. Flow Valves permit independent ram speed adjustment in both directions. Differential pressure between "A" and "B" gages caused by throttling effect of Flow Control Valve creates time interval in working pressure build-up, which is compensated for by Time Delay Switch setting. This insures consistently accurate working pressure on the ram.

- Holds dwell accurately to fraction of second
- Automatically re-sets
- Designed for millions of actuations

Pneu-Trol Time Delay Switch will hold any cylinder controlled motion or operation at a positive stop on either end of the stroke for ¼ to 60 seconds in 20 to 1 ratios. Simple, easy to adjust. Automatically re-sets after each actuation. Positive, controlled time dwell permits wider use of air or hydraulic power in automatic operations, increases accuracy of work by insuring split-second accuracy of time dwell. Available with many thrust linkages for left and right, down, up, or horizontal thrust. Write for Special Bulletin TDS-59

AUTOMATION AUTO PONENTS INC. COMPONENTS

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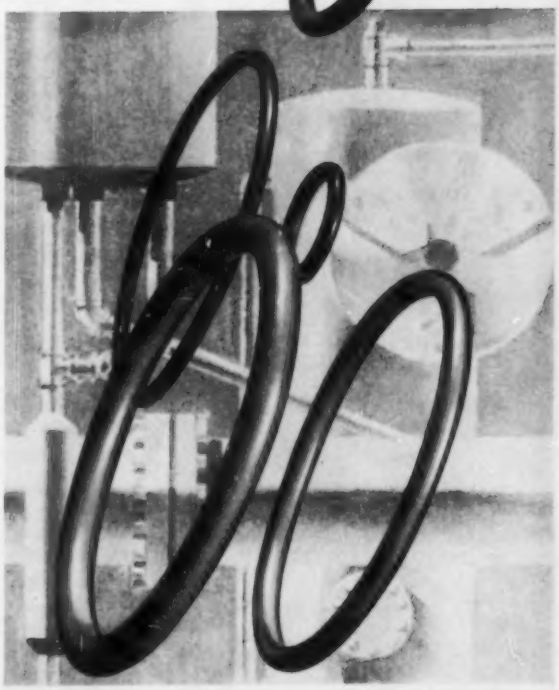
NOW...*for the first time, Stillman aircraft quality and know-how are available in* "O" INDUSTRIAL RINGS



Through Stillman Technology and volume production, Stillman high-quality O-Rings are available at extremely low cost. The same quality and reliability that are engineered into O-Rings for the aircraft and missile industries are also featured in the new Stillman Industrial O-Rings. These all-purpose seals are designed for use in all phases of industrial sealing, and are uniformly high in important features of chemical resistance, low swell, long life, and sealing dependability. Stillman O-Rings are stocked in a complete range of sizes for rapid delivery.

Write for the all-new Stillman Industrial O-Ring brochure, free on request.

NOTE: *Major distributorships still available in some major cities.*

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RELIABILITY
AND
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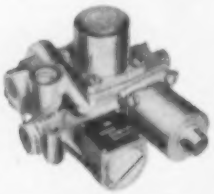
are our main products

First, imaginative design; then experienced thoroughness through development, tooling, production, assembly and tests, all under strict quality control in an unusually well equipped plant . . . we can help you solve your special problems . . .



- SOLENOID VALVES

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AVIATION NEWS

from the fluid power field

Benbow to produce Pantex valves

Benbow Mfg. Corp., Culver City, Calif., will manage future sales, design, and manufacture of the aircraft and missile components formerly produced by Pantex Corp., Newark, N. J. The agreement covers the Pantex line of hydraulic relief valves used on military projects. Also included are control valves, reservoirs, and similar items on qualified approval lists for military and commercial aircraft. Wayne Boals, vice-president of Benbow, will be in charge of sales.

Vickers receives Minuteman contract & appoints plant managers

The Aero Hydraulics Division of Vickers Incorporated has been awarded a 1.7 million dollar contract to produce integrated, battery-powered APU's for nozzle control units for all three stages of the Minuteman ICBM. This contract

Wilson

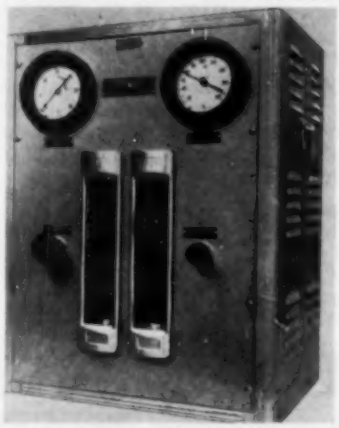
Rea

was awarded by Autonetics, a division of North American Aviation, Inc. The APU's are being produced at Vickers' Torrance, California plant where D. G. Wilson was recently appointed plant manager. Previously Wilson was industrial engineering manager of the Division in Detroit.

J. R. Rea has been appointed manager of Vickers' Joplin, Missouri plant. Rea has been with Vickers over 13 years.

REF names engineers, wins contract

REF Mfg. Corp., Mineola, N. Y., has made Joseph Bren a project engineer in its new Ground Support Equipment Section. Bren was



REF TEST RIG FINDS RATE OF AIR LEAKAGE from jet-engine sections. It uses shop air at 80 to 100 psi for static and dynamic tests. Filtered and metered air enters the engine through a panel-mounted, 3-way selector valve. Air passes from the rig to the engine through a 10' flexible hose. Pressure and temperature dials on the panel are accurate to 0.5% of scale. One flow meter covers 6.8 to 85 lb/hr. The other covers 0.8 to 10 lb/hr. The meters are accurate to 1% of scale.

formerly with Greer Hydraulics, Inc., Jamaica, N. Y. where he was responsible for design of aircraft test equipment. At REF, he will work on a new line of GSE.

Saul D. Wills is another new project engineer at REF. As assistant chief engineer at Greer, he directed design of testing devices for aircraft fuel components.

Scandinavian Airlines System, Inc. has awarded REF a contract on hydraulic accessories test stands for DC-8 jets. The stands will test all the aircraft's hydraulic components with controlled flow rates to 25 gpm, and pressures to 5000 psi dynamic, or 20,000 psi static.

Continued on page 124

Circle 124 →

SEALOL

AVIATION

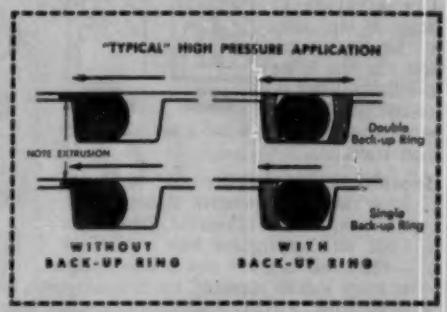
jets. This was expressed by Douglas Nickerson, Chief Engineer for

NOW—Increase O-Ring Life and Reduce Costs with...

Parbak*

The only contoured and continuous back-up ring... simplified, easy-to-assemble, resists higher pressures!

Here's the first really new back-up ring in years...
Test after test, both in the field and laboratory, has proved that Parbaks* greatly increase O-ring life.
In addition Parbaks* improve lubrication, are easy to assemble, and resist higher pressures — *yet they actually cost less* than back-up rings for similar useage!



Why not get the facts about these unique rings, now. Send for catalog 5482—8 pages of design data and other material about Parbaks.* It's free, of course.

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Culver City, California and Cleveland, Ohio
A DIVISION OF PARKER-HANNIFIN CORPORATION

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AIR-MITE AIR

SEALOL

Check Valves

for

POSITIVE CONTROL

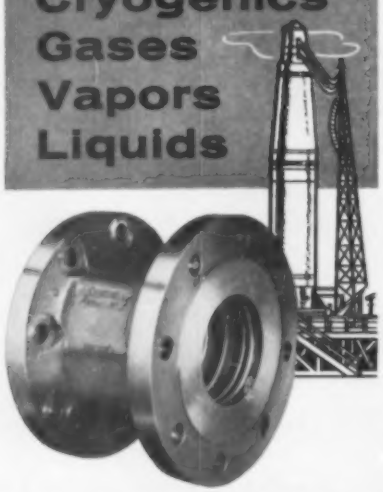
of

Cryogenics

Gases

Vapors

Liquids



New soft-seat design insures leak proof action over a broad pressure range

Low pressure (1 pound or less) seats the poppet on a resilient disc inset in the body. As pressure increases, the resilient disc is radially displaced and a metal to metal seat results.

Specifications — sizes from ¼" to 6" and larger. Materials are steel, stainless steel, aluminum, brass or as required. Pressures to 6,000 psi. Temperatures from —425°F to +400°F. Available with pipe or tube fittings or flange ends as required.

Fully qualified — all models meet or exceed MIL-V-5524A. Sealol Check Valves are used aboard newest atomic subs, in rocket fuel-mixing plants, launching equipment and numerous industrial applications.

Applications — current uses include the Polaris launching system and the Atlas fuel handling system. Also at the Liquid Rocket Plant of the Aerojet-General Corporation, the Titan fuel handling and mixing systems.

Send for Bulletin HP02 or call S. J. Biello at STuart 1-4700 (area code 401) for detail information.

SEALOL INC.

1510 **Post Road, Providence 5, R. I.**

Circle **145** on Time-Saver Card

AVIATION NEWS

from the fluid power field

Parker gets License on valve connecter

Parker Aircraft Co., has been licensed by Navan Products, Inc. to manufacture and sell a new valve connector for missile fueling. Navan is the invention-marketing subsidiary of North American Aviation, Inc. Parker is a division of Parker-Hannifin Corp., Cleveland, Ohio. The valve is so designed that it cannot be disconnected unless the fuel fill line is shut off. This eliminates spilling dangerous fuels.

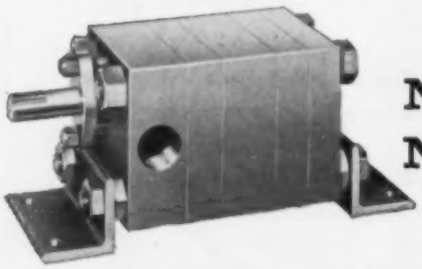
Proportional skid control

To avoid skids and offer maximum braking, automatic systems that detect slip in any wheel and relay corrective signals to control devices are required in the latest jets. This was expressed by Douglas Nickerson, Chief Engineer for Hydro-Aire Co., Burbank, Calif. Anti-skid braking systems should offer proportional control, Nickerson said, in which braking pressure is metered in proportion to wheel slip. Most systems have been of the "on-off" type which completely release and reapply pressure as often as the wheel tries to slip. Hydro-Aire announced a proportional type system, accepted for the forthcoming Convair 600 jetliner. It uses an analog computor for metering pressure to the brakes according to wheel slip.

Cooper named Sargent vice president

Roy F. Cooper, for the last 13 years chief engineer of Sargent Engineering Corp., Huntington Park, Calif., has been appointed vice president-engineering. Cooper is a specialist in hydraulic, pneumatic, and mechanical components and systems. He had engineering responsibility for the complete hydraulic handling and launching system for the Regulus missile.

for pumps as individual as a fingerprint!



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Northern designs and builds quality into every pump. For each application, materials are selected with infinite care—gears with ground tooth form for perfect contact, correct clearances. Meticulous inspection at every stage in the manufacturing process assures efficient, economical, lasting service for even the most difficult pumping tasks under rugged conditions, indoors and out, year after year.

Northern Nitralloy Pumps are available in capacities from ¼ to 146 GPM at pressures up to 2000 PSI. Within this range there is a pump as individual as a fingerprint — as "special" as you want it.

Write today for free catalog and engineering data.

Northern Ordnance Incorporated

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Minneapolis 21, Minnesota

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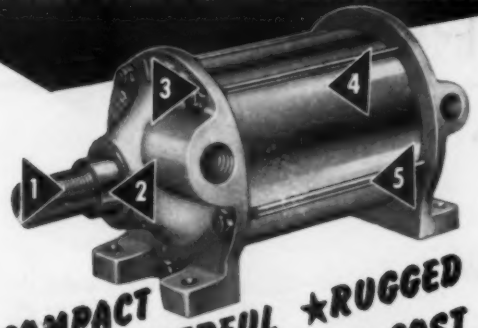
AIR-MITE AIR CYLINDERS



★COMPACT ★POWERFUL ★RUGGED ★LOW COST

AIR-MITE Cylinders—made in Single or Double Acting Series, in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling, or lifting is required, AIR-MITE Cylinders will meet your most exacting requirements of dependability and long life. Write for complete catalog and prices.

QUALITY FEATURES:

1. Ground and polished steel ram
2. Bronze oilless ram bushing
3. High strength aluminum alloy cylinder heads
4. Brass, true-bore cylinders
5. Five steel tie rods

92

AIR-MITE DEVICES, INC.

4001 W. Kinzie St., Chicago 24, Ill.

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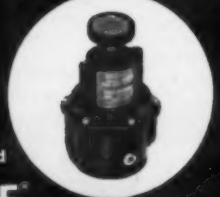

Catalog gives performance and other data on 18 models of precision pneumatic pressure regulators. (pipe sizes ¼" to ¾" NPT)

STRATOS®

A DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORPORATION

INDUSTRIAL PRODUCTS BRANCH

West Babylon, L. I., N. Y.

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3 CLASSES

OF PRESSURE GAUGES meet all service demands

1.

◀ ASHCROFT DURAGAUGES. The finest pressure gauges built—highest in sustained accuracy and durability. Ideal for the toughest services. Save many times their initial cost in replacements and repairs.

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ASHCROFT QUALITY GAUGES. Tops in general-purpose gauges — second only to the Duragauge. Available for pressure, vacuum or compound services in low, medium, and high ranges. ▶

3.

◀ ASHCROFT STEEL CASE GAUGES. None better for small equipment like portable compressors, pumps, and for less important pressure lines. Pressure, vacuum, and compound ranges available.

Ashcroft dial sizes range from 2" through 24" . . . pressures from 30" vacuum or a few ounces up to 100,000 psi . . . materials to suit the application. Among the many Ashcroft Gauges are Maxisafe®, pneumatic receiver, recording, chemical, special purpose types, and various gauge testers. Invest wisely. Make your selection precisely for the job. Chose from the complete line of Ashcroft Gauges. Write for Catalog 300 B.

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Specify the very best !

ULTRA PRECISION

DISC TYPE—0.5 PSI CRACK AVAILABLE TO .06 PSI CRACK VERY LOW BACK PRESSURE

ONE PIECE BODY

DISC TYPE, 2—8 PSI CRACK ¼—⅜—½ F.P. BRASS HIGH PRESSURE—LEAKPROOF

ONE PIECE NIPPLE

DISC TYPE—2 PSI CRACK ¼—⅜—½ M.P. BRASS EXCELLENT FLOW—LEAKPROOF

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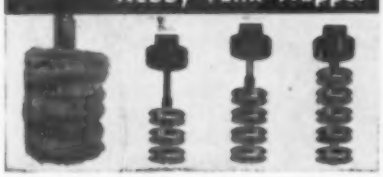
CUSTOM DESIGNED AND BUILT CHECK VALVES FOR HUNDREDS OF INDUSTRIES—QUANTITY PERMITTING

BODNAR & McDERMOTT MFG. CO. INC.

23 BEECHWOOD AVE. MT. VERNON, N. Y.

NEW MAGNETIC CLEANER for HYDRAULIC POWER UNITS the Kebby Tank-Trapper



★ Powerful Alnico V Magnets
★ Highest Active Area
★ Engineered for Power Concentration
★ Easy to Apply
★ Low Priced . . . Quick Delivery
★ No Moving Parts . . . No Maintenance

MEETS NEW J.I.C. HYDRAULIC STANDARDS

The Kebby Tank-Trapper is specifically designed to complete the protection of hydraulic systems against damage by iron particles worn off moving parts of various components. It picks up material missed by the filter and prevents premature filter loading. Expensive shut downs and service calls are drastically reduced. Write for Bulletin 1-500-59.

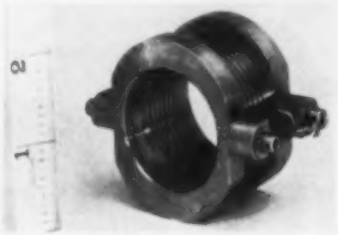
THE KEBBY COMPANY
2320 Custer Avenue Rockford, Illinois
Designers and Manufacturers of Magnetic Devices, Kebby Mite and Filtray Coolant Cleaners

Circle **90** on Time-Saver Card

AIRCRAFT COMPONENT DATA

High Temperature & Pressure Seals . . . new bulletin available

Bulletin 101SD describes aircraft and missile seals. Includes sizes, types, and installation diagrams for rotary face seals, static spring seals, reciprocating rod, and piston seals. Also describes new lightweight bellows. Rotary face seals with machined bellows for high speed shafts withstand temperatures from —320F to 1200 F and speeds to 75,000 rpm. Diameters to 10". Nickel alloy, reuseable static spring seals are for continuous service in vacuum or high pressure, and temperatures from —320



F to 2000 F. Sizes are from a fraction of an inch to several feet in diameter. A variety of rod and piston seals are available for dynamic sealing from —65 F to 1200 F and pressures above 4000 psi. Lightweight bellows made by new process without drawing or forming. Low force needed for axial or angular flexing. Over 3000-psi pressure. Sizes from ¾" to 60" diameter.—*Skinner Seal Division, Hydrodyne Corp., North Hollywood, Calif.*

Circle **500** on Time-Saver Card

Rupture Discs . . . to 50,000 psi

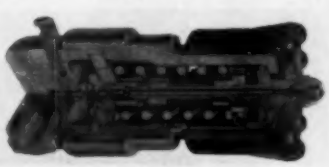
Catalog describes new prebulged rupture discs, models H-O and H-O-V, designed to operate closer to rupture pressure than conventional prebulged discs. Another recent development: the CPV disc has a low rupture pressure, yet is highly resistant to handling damage during installation. Catalog describes other discs from ¾" to 30" diameter and pressures from 5 psi to 50,000 psi. Rupture disc assemblies, which consist of a rupture

disc and its vacuum support, are available in bolted, union, and screw designs. Standard material for bolted design is carbon steel with alloy steel studs and hardened nuts. Sizes from ½" to 30". Union assemblies stocked in carbon and stainless steel. Six size ranges from ½" to 2". Screw assemblies are adaptable to missiles and rockets. Standard construction is type 303 stainless steel for inlet and carbon steel for outlet and holddown rings. Standard screw unit has burst pressures to 6000 psi at 100 F, higher pressures are available.—*Fike Metal Products, Blue Springs, Mo.*

Circle **501** on Time-Saver Card

Small Volume Pressure Regulators . . . inlet pressures to 10,000 psi

Pressures controlled or reduced to a maximum of 6000 psi. ¼" and ⅜" sizes. For missile and



spacecraft industry use in test benches and consoles to control static pressures. All metal parts in contact with line fluid, including

Continued on page 128

Circle **147** on Time-Saver Card

THE CYLINDER for jigs, fixtures and automation!

SHEFFER **Valv-N-Hed**®

CLA-SV SERIES

INTEGRAL SOLENOID VALVE, SPRING RETURN 1⅛ BORE CLAMP TYPE CYLINDER

For air, oil or water operation. May be face, front flange, or horizontally mounted. Stock strokes 1", 2" and 3". Other strokes and double acting type available. All materials corrosion-resistant. Employs time tested and proved SHEFFER CLA SERIES cylinder. Ease of operation and extreme compactness makes it ideal for automation, jigs, and fixtures.

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Circle **144** on Time-Saver Card

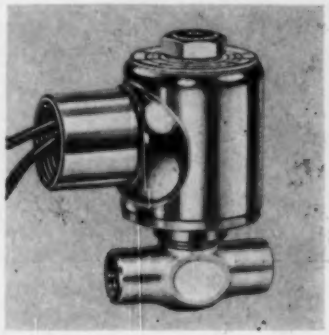
HOKE Flow Sheet

HOKE REPORTS ON FLUID CONTROL (1)

A VALVE NAMED "DESIRE"

With apologies to Tennessee Williams, we really have produced a Solenoid Valve line based on *your* desires. We surveyed all the solenoid valve users we could find to determine what *you* wanted. The result is Hoke's "User Designed" Series 90 and 95, two-way and three-way, direct-acting solenoid valve line.

Thanks to you, we have much to brag about. Here's what we have been saying about these new valves: lightest weight – smallest size – no-hum operation – lowest temperature rise–lowest power consumption – stainless steel plunger – silver AC shading coils – easiest installation – packless construction –360° rotatable housing – operates in any position.



We make them of forged brass or stainless steel, in ⅛" and ¼" NPT size or JIC tube ends. There's a variety of AC and DC voltages. Class "A" coils are standard, but Class "H" are also available for temperatures above 212°F. For those with high insurance rates, we can supply explosion proof coil housings.

Now that we've bragged a bit, we must also apologize for our premature enthusiasm. We were so excited about this product that we stirred up a hornet's nest of interest before we were ready to deliver in quantity. Shipments were slow at the start, but now we can have any reasonable quantity of these "desirable" solenoid valves "on-stream" in your plant when you want them.

There's only one way to get conclusive performance proof – buy a valve. Ask for Bulletin SV-1159.

FREE! A STEADY FLOW OF FACTS!

Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

Hoke's Performance Guarantee – **Every Valve Leak-Tested!**

HOKE INCORPORATED
87 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

☐ Solenoid Valves ☐ Have a salesman call
☐ Flow Sheet ☐ Complete Catalog GC 960

NAME_____ TITLE_____

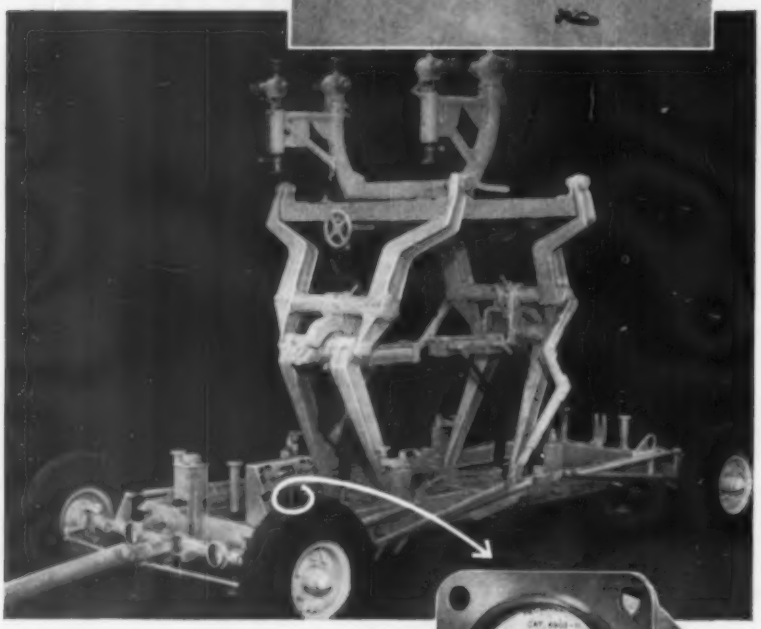
COMPANY_____

ADDRESS_____

CITY_____ STATE_____

Circle **77** on Time-Saver Card

At the right a McDonald *Green Quail* Missile is being launched from a B-47. The *Green Quail* ground support trailer is shown below.



Trailer mounted RMC-Lindsay pressure gauges give fast, dependable systems check for unerring flight of Green Quail

Fast, because they are designed for maximum readability and quick response. Dependable, because of their simple direct-drive operation and precise construction.

The RMC-Lindsay gauge is completely different from the usual pressure gauge. Instead of the common "C" type bourdon tube, the RMC pressure element is a helical bourdon coil which offers greater resiliency and longer accurate cycling life. Instead of the pointer being actuated through the usual linkages, gears, hair springs and the like, the RMC pointer is attached directly to the end of the helical bourdon pressure element. This eliminates waver and lag, wear and slippage; provides exceptional resistance to the destructive effects of vibration, shock and pulsating pressures.

For complete information, write, wire or phone:

RMC

ROCHESTER MFG. CO. OF CALIFORNIA
1401-C S. Shamrock Avenue, Monrovia, Cal.

ROCHESTER MANUFACTURING CO., INC.
209-C Rockwood Street, Rochester 10, N.Y.

LINDSAY PRESSURE GAUGES

Circle **139** on Time-Saver Card

AIRCRAFT COMPONENT DATA

filter, are stainless steel. Regulator designed with minimum number of parts to reduce maintenance and boost repeatable accuracy. A single screw adjusts the sensitivity range of the downstream relief function. No external piping needed other than supply and outlet lines. Construction permits supercleaning.—*Grove Valve and Regulator Co., Oakland, Calif.*

Circle **502** on Time-Saver Card

High-Pressure Precision Pumps
. . . wet or dry swash-plates

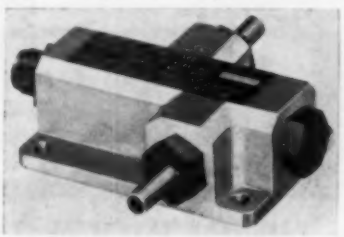
Deliver 1 gpm at 2500 psi and 4000 rpm. Wet swash-plate models (left) for pumping non-corrosive liquids, including low-lubricity fluids. Dry swash-plate units

(right) are for pumping corrosive liquids such as nitric acid, hydrogen peroxide, and hydrazine. Volumetric efficiency is 95% and over-all efficiency is 80%. Can operate intermittently to 8000 rpm and 10,000 psi. Both pumps provide uniform, nonpulsating output. Larger pump is 3½" long, less shaft, x 2.75" diameter and weighs 36.5 oz.—*Clevite Ordnance, Division of Clevite Corp., Cleveland, Ohio.*

Circle **503** on Time-Saver Card

Hermetic Valves
. . . have piston poppets

For hard-to-handle fluids and gases. Explosive squib actuates



valve. Maintains storage life of 18 months at temperatures between −20 and 160 F, with or without

Continued on page 130

Circle **7** on Time-Saver Card

NEW!

SOLENOID PILOT-OPERATED 4 WAY VALVE

- Separate valve body and solenoid-pilot assemblies for fast, easy servicing.
- Coils (properly applied) guaranteed against burn out for life of valve.
- Low current in-rush (0.26 amps. at 115 volts).
- No springs in main valve.
- Unusually compact design.

Priced well below average.

AIR VALVES COMPANY
24581 Graesbeck Hwy. • Warren, Mich.

STAFFA

HIGH TORQUE VARIABLE SPEED (1-100 r.p.m.) HYDRAULIC MOTORS

Mark IV—5 cylinder 4,500 lbs. ft. at 2,000 p.s.i. (Speed 1-100 R.P.M.) **Mark V**—7 cylinder 6,600 lbs. ft. at 2,000 p.s.i. (Speed 1-75 R.P.M.) Overall efficiency 90% to 95%.
Ideal drive for conveyors, rolling mills, cranes, tractors, drills and most mechanical handling applications.
Ask for details of hydraulic cylinders, valves, pumps and motors.

CHAMBERLAIN INDUSTRIES LTD

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Leytonstone 3678

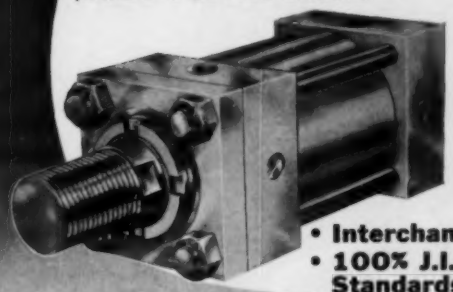
(Member of the Chamberlain Group of Companies)

Circle **35** on Time-Saver Card

For Smooth, Precise, Sure Power

HIGH-PRESSURE HYDRAULIC CYLINDERS

2000 PSI
(3000 PSI non-shock)



- **Interchangeable**
- **100% J.I.C. Standards**

12 Bore Sizes: Compact 1⅛" thru 12"

Quick-Change Front Removal Cartridge
Self-contained unit externally removable, no need to loosen tie rods or dismantle the cylinder.

"Clinch-Tite" End Seal
Maintains leakproof seal at all pressures, ends "O" ring extrusion at pilot fit.

Interchangeable Cushion Check and Adjustment
For maximum flexibility; space-saving flush design; easy to adjust.

Heli-Coil® Piston Lock
Easy rod service with no loss of thread strength; meets rigid aircraft standards.

A-707A

MORE POWER from line air with S-P BOOSTERS

For *intensified* hydraulic pressure that you can control for punching, riveting, clamping, pressing, shearing, crimping—add an S-P Air-Oil Booster to your air line—no maintenance, no pumps, no valves; saves space, uses line air to hold intensified pressure as long as desired. Write for Catalog 116.

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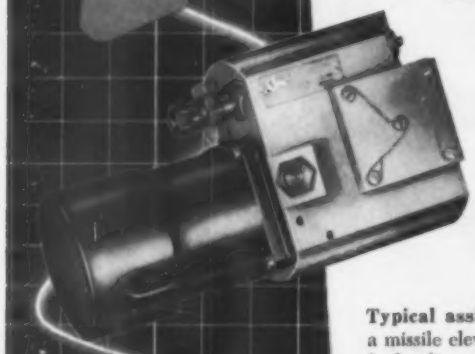
Circle **143** on Time-Saver Card

BUILD ON...

Eastern

CONTROL EXPERIENCE:

SERVO SYSTEMS



Typical assignment: design and develop a missile elevon control servo with a single hydraulic power supply and three actuators. Weight and space considerations critical.

Solution: a system designed and built around the Eastern E/HS 5 type 100A hydraulic power supply, using a 400-cycle motor. Minus motor, but including pump, reservoir, expansion chamber, pressure regulating valve and filter, the supply weighs only 2.6 lbs.

Eastern achieved a 20% saving in hydraulic power supply capacity by the use of one of its own *pulse length modulated* single-stage servo valves, manifolded to each actuator. Zero first stage leakage, zero hysteresis, plus the high response and efficiency which characterize this valve contributed to the successful meeting of the demanding requirements.

Specifications:

force level: 300 lbs.
total stroke: 1/2 in.
max. velocity: 1.5 in./sec.
time constant: 0.1 sec.
max. actuator width: 1.25 in.

For genuine contributions to the solution of your servo problems, call in the Eastern engineer.

servo-valves • fuel controls • actuators

EASTERN INDUSTRIES INCORPORATED
100 SKIFF STREET
HAMDEN 14, CONN.

Eastern AVIATION PRODUCTS

Circle **52** on Time-Saver Card

AIRCRAFT COMPONENT DATA

fluid pressure applied. All metal. No burst diaphragms, shear plates, or other tear-out elements used to obtain hermetic seal. Units can be manifolded together.—*Dyna-Matics Corp., Sun Valley, Calif.*

Circle **504** on Time-Saver Card

Miniature Pressure Transducer

. . . weighs 8 grams

Unbonded strain gage transducer is ¾" diameter x ½" high. Type 4-325 is for accurate pressure measurement under extreme

conditions in a small space. Spring-type sensing element with four active arms attached to a force-summing diaphragm gives an electrical output proportional to pressure applied to it. Sensing element is in a stainless steel case. Pressure ranges are 10 to 100 psia, 2 to 100 psig, and ±2 to ±50 psi differential. Pressure limit is 1.5 times rated pressure without calibration shift and 2 times rated pressure without permanent damage. Operates at temperatures from −320 F to 300 F.—*Consolidated Electrodynamics Corp., Pasadena, Calif.*

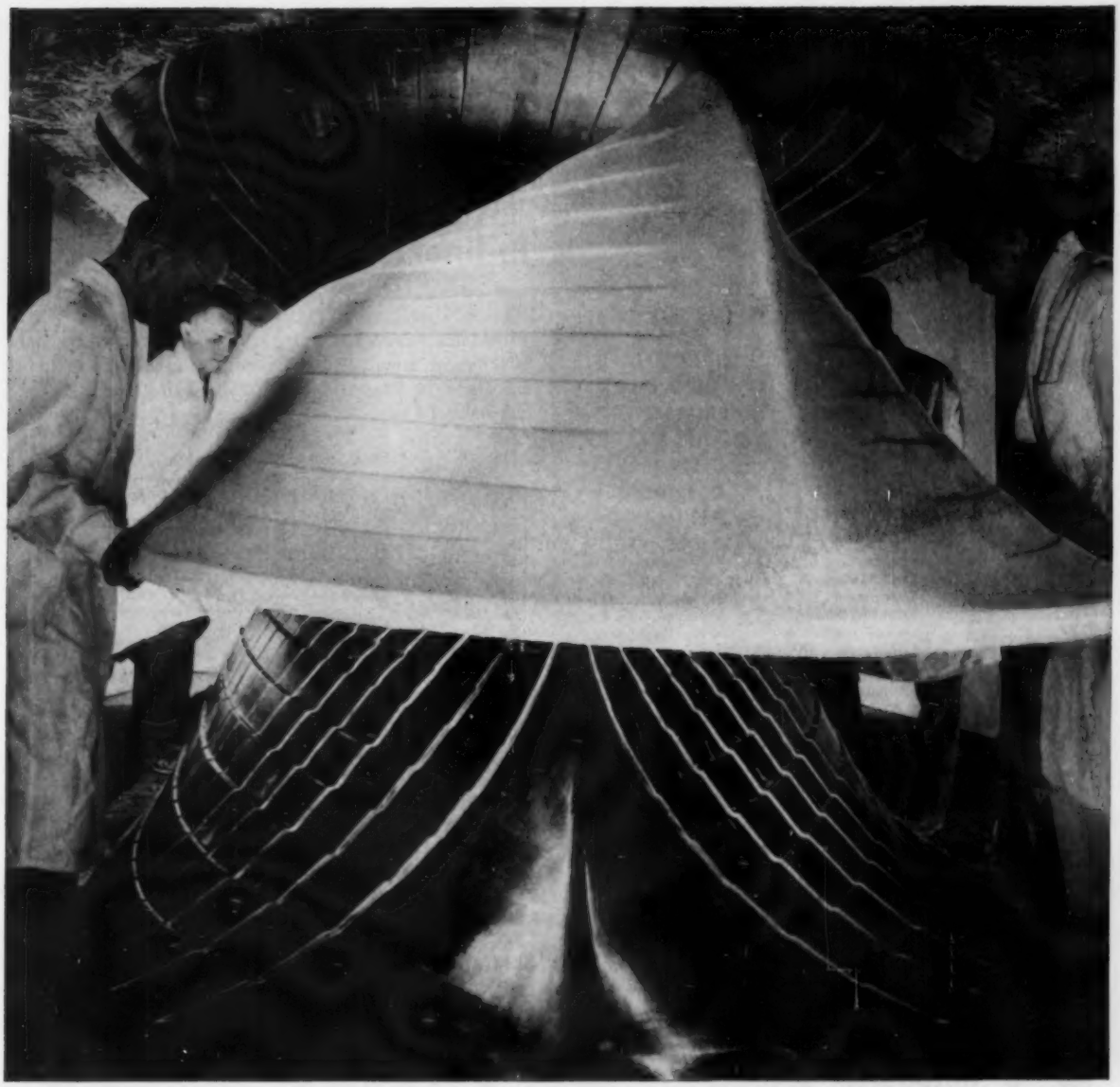
Circle **505** on Time-Saver Card

Pressure Switch

. . . weighs less than 1.5 oz

Has Belleville spring pressure sensing area for vibration-proof operation. Pressure range of model 608 GC is 2 to 750 psi, proof pressure is 4500 psi, temperature range is −65 F to 250 F. Special models to 10,000 psi proof pressure and temperature range from −340 F to 1000 F. Pressure capsule accepts any media compatible with 347 stainless steel. Electrical switch is UL approved. Rated 5 amp, 125, 250, and 460 vac and 5 amp, 28 vdc, SPDT.—*Custom Component Switches, Inc., Burbank, Calif.*

Circle **506** on Time-Saver Card



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Birth of a boat–with the help of Sun Hydraulic Oils

You can take it for granted that today's fiber glass boat hulls, molded in giant hydraulic presses, are leakproof. That's one of their greatest virtues. However, it takes top quality hydraulic oils and service to keep these presses at peak efficiency.

That's why your Sun Representative is a good man to have at your side. Widely experienced in solving hydraulic problems, he can spot the causes of difficulties quickly. He'll analyze your requirements for hydraulic oils . . . and recommend the type best suited to your specific needs.

He can do this because Sun produces a wide range of hydraulic oils to accommodate any system, and to keep it in continuous, trouble-free operation.

In fact, Sun offers dozens of quality products designed for specific applications: oils, greases, waxes, and petrochemicals, just to name a few.

You're certain to find the right petroleum product at Sun to meet your most exacting requirements. Write to Dept. AH-10, SUN OIL COMPANY, Phila. 3, Pa.
In Canada: Sun Oil Company Limited, Toronto & Montreal.

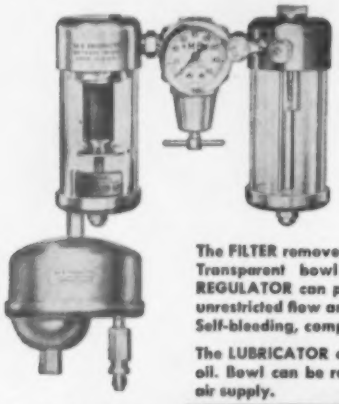
ORIGINATORS OF FAMOUS CUSTOM-BLENDED BLUE SUNOCO GASOLINES

Circle 101 on Time-Saver Card

GREATER PROTECTION to your AIR LINE!

M·B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)



SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039 and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

The LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

The Air Trap is automatic and eliminates manual draining.

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DETROIT 3, MICHIGAN

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PACKINGS to your specifications in leather, synthetics, asbestos, teflon, etc.

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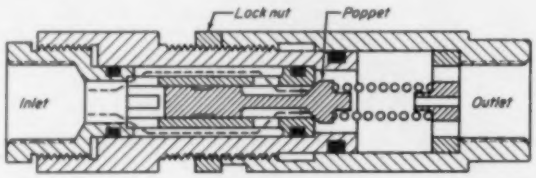
Circle 16 on Time-Saver Card

FLUID POWER PATENTS

In-line Relief Valve

Valve is designed for aircraft. It meets the U. S. Armed Forces specifications for weight, space, and efficiency. Control of forces within the valve prevent the poppet from chattering. It has only one moving part and is accurate within 2% of its setting. The valve can be adjusted externally.



• **Operation**—The inlet port connects to the pressure source to be relieved, and the outlet connects to tank. Fluid under pressure enters the valve and flows through ports in the body to the chamber under the valve seat.

When system pressure, applied to the left end of the poppet, is sufficient to overcome spring force, the valve opens. Spring force is increased by threading the two halves of the valve together, compressing the spring. A locknut holds the setting.

Total flow area through the valve is greater than the area through equivalent pipe size.

Valve chatter is eliminated because the area on which system pressure acts to open the valve does not change when the valve opens.

U. S. Patent No. 2,884,952 by Walter Mason and Stephen J. Biello, Assigned to Avco, Inc., Rhode Island.

Servo Control for a Profile Lathe

• **Operation**—A nozzle-flapper pilot valve, actuated by a stylus following a profile cam, shifts the main control valve to position the tool feed cylinder.

The rod end of the cylinder is always under pump discharge pressure. The tool post attaches to the cylinder barrel. It extends and retracts by increasing or decreasing flow to the cylinder's head end. The tool is held rigid by maintaining pressure on both sides of the piston.

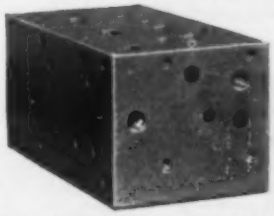
Fluid from each end of the main valve spool drains to tank through feedback nozzles. These nozzles create a pressure difference when the spool is shifted, which tends to center the spool.

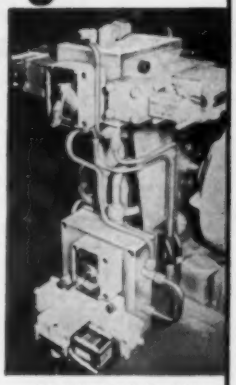
The pilot valve actuator connects to a stylus which follows a profile cam. As the actuator moves the flapper to close off the right nozzle, pressure builds up

Continued on page 134

Circle **172** on Time-Saver Card

Your manifold problems *Solved*





We are Drilled Manifold Specialists! We can manufacture to your specifications . . . or design special manifolds to fit your needs.

Will accommodate from ⅛" to 1½" valves.

Drilled manifolds of solid ground steel offer such advantages as:

- LOWER COST
- COMPLETELY LEAK-FREE
- MORE COMPACT
- BETTER APPEARANCE
- EASY VALVE SERVICING

Send for FREE Booklet

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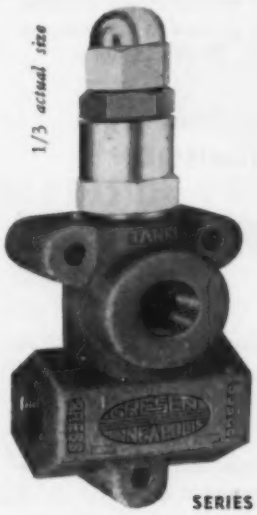
1/3 *actual size*



TWO NEW RELIEF VALVES

GRESEN HYDRAULICS

SERIES J (*High-lift ball and spring type*)
ONLY $16.50*

SERIES PJ (*pilot operated*) **$19.50**

Both series feature unique design for minimum *crack* to *full-flow* pressure differential and smooth, quiet operation. Both series, designed for *in-line* mounting, are available in ¾" and 1" pipe sizes and ¾", ⅞", and 1" tube sizes. Pressure adjustment range: 400-2500 psi for the PJ series, 400-2000 psi for the J series. Capacities up to 40 gpm (PJ series), 16-38 gpm (J series).

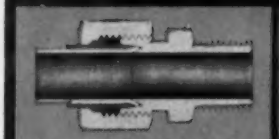
**Prices are FOB Factory and subject to trade discounts*

WRITE FOR LITERATURE

GRESEN *Mfg. Co.*
405 35th Ave. N.E., Minneapolis 8, Minn.

Circle **67** on Time-Saver Card

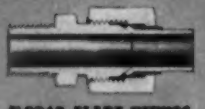
FLODAR HAS THE FITTING!



FLODAR SELF-FLARE FITTINGS
Fitting Flares the tube I.D. and O.D. Seal

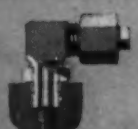
FLODAR SELF-LOCK FITTINGS
For Nylon & Plastic Tube

FLODAR NO-FLARE FITTINGS
No Thread, No Flare, No Solder or No Welding

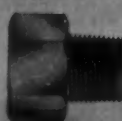


FLODAR FLARE FITTINGS
37° — J. I. C. Standard

FLODAR SELF-SEAT FITTINGS
Metal-to-Metal Seal — No pipe threads



"O" RING FITTINGS
S. A. E. Straight Thread — AN Hex



FLODAR PIPE FITTINGS
Machined Dry-Seal Threads

...your most complete source for all types.

No matter what type of fitting you require — for hydraulics, pneumatics, instrumentation, lubrication or process piping, FLODAR can furnish the tube or pipe fitting best suited to your individual needs.

Because FLODAR furnishes all three basic fitting styles — Self-Flare, No-Flare and Flare-Type—you can count on unbiased recommendations for your job. Broad application experience on all kinds of fitting problems backed-up by advanced designs and skilled workmanship are your assurance of leakproof fluid systems.

Flodar Fittings are available in every standard shape with sizes from ⅛" to 2". They are available in steel, brass, stainless and aluminum.

FLODAR FITTINGS ARE J. I. C. APPROVED

Write for information on the complete FLODAR line.

FAST DELIVERY FROM LOCAL STOCKS IN 50 STRATEGIC POINTS THROUGHOUT THE UNITED STATES AND CANADA

Fittings Protected by U.S. and Foreign Patents. Other Patents Pending.
Copyright Flodar Corp. 1960

F **FLODAR Corp.**
16911 ST. CLAIR AVE. • CLEVELAND 10, OHIO
Pioneers in the development of fluid-power fluid systems

Circle **55** on Time-Saver Card

Now available... the NEW KWIK-CHANGE BOWL

exclusively on the WILKERSON #3014 LUBRICATOR

Simply touch the quick-release locking lever, turn bowl slightly and bowl is off in a second . . . without using tools or removing screws, clamps or rings. Can't be removed accidentally.

SAFE—valve bleeds air pressure from bowl when locking lever is touched

Profit from these protective advantages of a Wilkerson 3014 Lubricator

- ★ 1 to 300 CFM
- ★ Site-Flo gauge
- ★ Two fill holes
- ★ Fill while air pressure is on
- ★ Bowl can be removed without turning off air

PLUS . . .

The time-saving advantages of the Wilkerson

KWIK-CHANGE BOWL

Note: 3014 lubricator can be equipped with the Wilkerson autofill mechanism to maintain lubricant at safe level.

Get complete information on the versatility and cost saving advantages of the new 3014 series.

WRITE FOR CIRCULAR #1028

WILKERSON CORPORATION

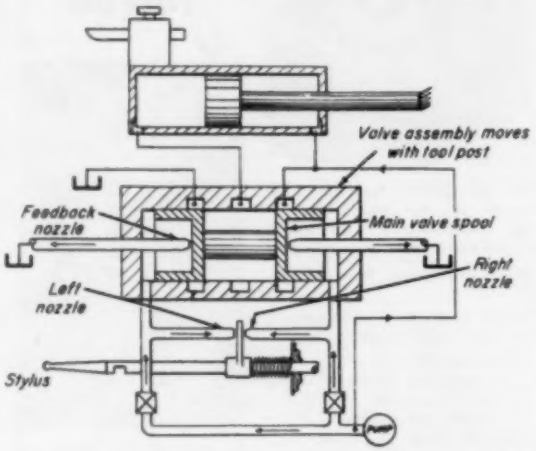
Dedicated to keeping the NEW in pNEUmatics

1643 West Girard • Englewood, Colorado

Circle **167** on Time-Saver Card

FLUID POWER PATENTS

on the right side of the main valve spool and moves it left. Fluid from the head end of the cylinder drains through the valve to tank. The cylinder barrel, valve body and spool, and the cutting tool move right. With the spool shifted left, flow through the left feedback



nozzle decreases and pressure builds up at the left of the spool. This pressure, tending to move the spool right, is opposed by the pressure on the right of the spool caused by the flapper partially closing the right nozzle. The spool remains shifted until the tool reaches a position corresponding to the stylus. The flapper is then centered between its nozzles and the feedback nozzles center the spool to its neutral closed position. *U. S. Patent No. 2,872,934 by Donald P. Eckman, assigned to Warner & Swasey Co., Cleveland, Ohio.*

Other Patents Issued

HYDROSTATIC TRANSMISSION CONTROL VALVE

No. 2,893,260 by Robert Lapsley, assigned to Clark Equipment Co., Buchanan, Mich.

UNLOADER VALVE

No. 2,875,774 by Oscar H. Banker, assigned to New Products Corp., Skokie, Ill.

FLUID MOTOR

No. 2,878,787 by Elmer C. Stolz and William J. Zeefeld, and Elmer J. Stoltz, Sacramento, Calif.

HYDRAULIC SYSTEM (BLEEDING & FILLING)

No. 2,882,686 by Raymond C. Griffith, Detroit, Mich.

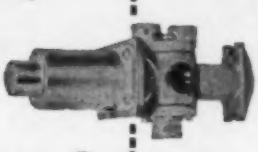
VARIABLE VOLUME PUMP AND VALVE

No. 2,887,060 by Cecil E. Adams and William E. Eschilman, assigned to American Brake Shoe Co., New York, N. Y.

BLAMING COIL BURN-OUT ON THE SOLENOID? THEN TAKE A CLOSER LOOK AT THE **VALVE!**

~~SPOOL and POPPET Valves bind and stick as dirt collects... overload solenoid and cause coil burn-out.~~

"SHEAR-SEAL" Valves are not sensitive to dirt... always retain solenoid power margin.



D.C. SOLENOID "SHEAR-SEAL" VALVES 0 to 10,000 P. S. I.

A.C. SOLENOID "SHEAR-SEAL" VALVES 0 to 10,000 P. S. I.

EXPLOSION PROOF A.C. and D.C.

SOLENOID "SHEAR-SEAL" VALVES 0 TO 10,000 P. S. I.

~~SPOOLS and POPPETS leak... can't compensate for normal wear.~~

"SHEAR-SEAL" Valves stay leakproof... a spring takes up the normal wear.

ASK FOR CATALOG V-59-60

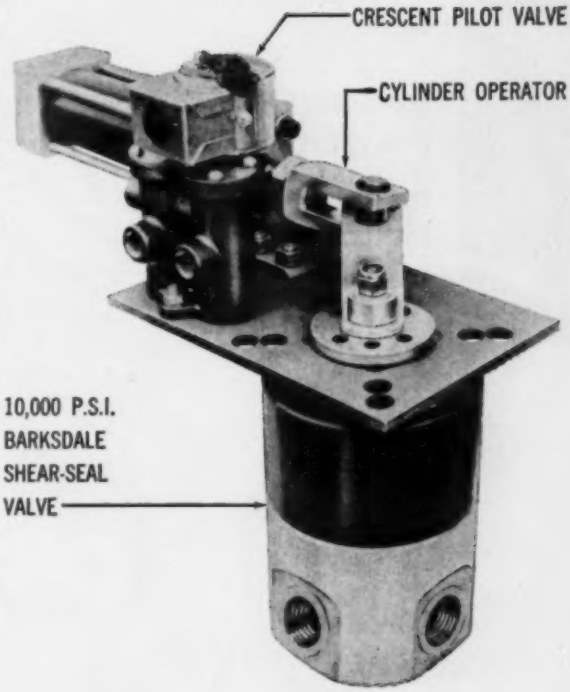
CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **22** on Time-Saver Card

CYLINDER OPERATED "SHEAR-SEAL" VALVES



Remote control operators for 10000 P.S.I., 6000 P.S.I. and 3000 P.S.I. "Shear-Seal" Valves are available with cushioned or non-cushioned cylinders.

4-Way, 3-Way and Shut-off valves range in pipe sizes from ¼" to 1½" N.P.T.

For complete data request catalog COV-60-61.

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **23** on Time-Saver Card

ENGINEERED PRODUCTS

for
Hydraulic-Pneumatic
Service

TOP EFFICIENCY WHERE FLUID POWER IS INVOLVED

Garlock Leather Cups actually tend to polish metal surfaces they contact. Provide good resistance to abrasion and wear . . . unmatched for tensile strength and toughness . . . low coefficient of friction, minimum cold flow. All sizes, shapes, designs available for wide variety of pressures, temperatures, non-caustic fluids. For severe service conditions, rubber fabric-inserted cups are also recommended. Catalog AD-121.

Garlock CHEVRON* Packings are as close to "frictionless" as you'll find. As pressures increase, the packing rings tighten to prevent leakage; with declining pressures, the rings ease off, permitting free operation of the rod, ram, or piston without leakage. Once installed, need no further adjustment to meet pressure variations. Available in many materials, including Teflon† for practically all applications. Catalog AD-115.

CHEMISEAL* Nylon Pressure Tubing by Garlock is the ideal answer for hydraulic and pneumatic lubrication, oil, and fuel lines and vacuum system connections. It resists fatigue, abrasion, impact . . . withstands temperatures from −60° F to +180° F and higher. 1000 and 2500 psi grades available, conforming to J.I.C. specs. You can flex it or bend it for greater design freedom, versatility. Catalog AD-177.

GARLOCK

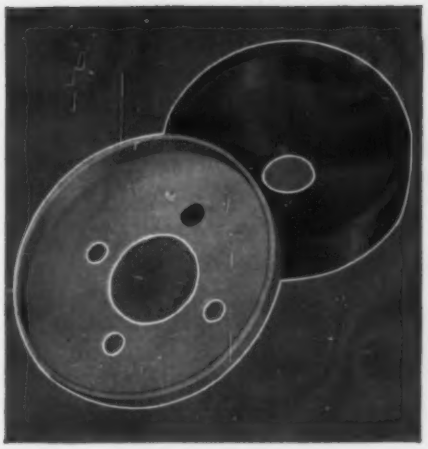
Take advantage of this "know-how" in the design field. Talk to your local Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U.S. and Canada. Or, write Garlock Inc., Palmyra, N.Y.

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

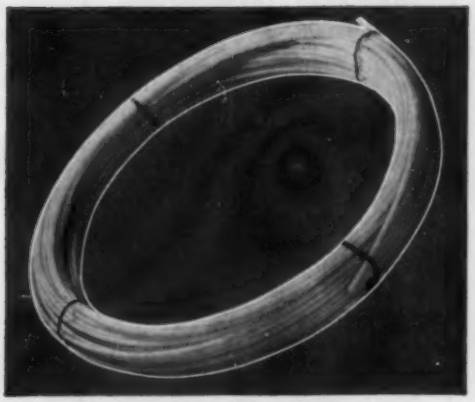
Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

*Registered Trademark
†DuPont Trademark



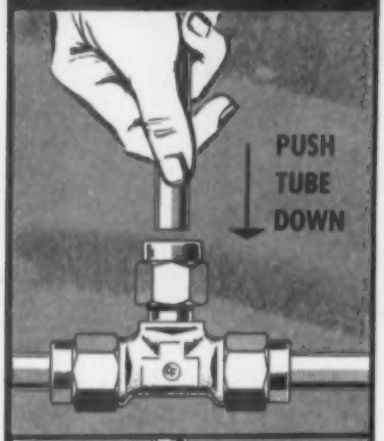
LEATHER CUPS are naturally tougher than other materials . . . suitable for most applications.

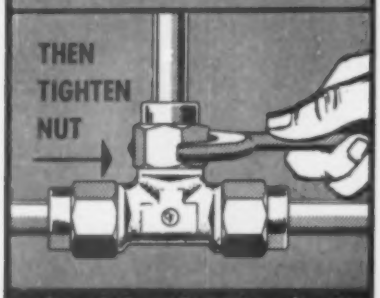
CHEVRON PACKINGS permit free operation with minimum friction at all pressures . . . last longer, need less maintenance.



CHEMISEAL NYLON PRESSURE TUBING is unaffected by many solutions which corrode metal . . . costs less than metal . . . available in $\frac{1}{8}$", $\frac{3}{16}$", $\frac{1}{4}$", $\frac{5}{16}$", $\frac{3}{8}$", $\frac{1}{2}$" O.D.; special sizes on request.

NEW
Rubbernek
FLARELESS
FITTING
provides simplest fastest assembly





Just 1-2 and you're thru!

Foolproof Installation!

Get perfect and time-saving installation every time with Rubbernek! Simply loosen nut and slip tube end into fitting until it bottoms. Then tighten nut against mating part. This positive stop of the nut prevents over and under torqueing. No flaring or tube preparation necessary.

Hydrostatic tests prove Rubbernek's seal-tight properties are maintained at pressures in excess of 20,000 psi*.

Chicago Forging invites you to test Rubbernek under your most critical conditions.

*Test data available upon request

Rubbernek

absorbs vibration, shock. Leakproof at very high pressures. Pressure tight at extreme vacuum. Conforms to J.I.C. standards. Can be reconnected repeatedly. Exceeds MIL-F-5506-A requirements.

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CHICAGO FORGING
& MANUFACTURING CO.
2004-A SOUTHPORT AVENUE
CHICAGO 14, ILLINOIS

Circle **36** on Time-Saver Card

NEW PRODUCTS

Continued from page 54

4-WAY VALVE

Air-cooled solenoids are retained in their cover, not mounted separately. Cushioned for shock-free performance.

Specifications: Nominal rating is 8 gpm. Can handle 12 gpm. Subplates have ⅜" ports or ½" ports which permit larger flows. For 3000 psi. Long-lasting solenoids are rated for 115 vac, 50 or 60 cps. Valve is also available with oil-immersed solenoids.
Vickers, Inc., Div. Sperry Rand Corp., Detroit

Circle **310** on Time-Saver Card

PIPE PLUGS

Seals without sealing compound. Do not loosen under vibration. For all types of organic fluids. Hollow inside plug increases sealing ability —as pressure increases, plug threads are forced tighter against mating threads. When used in tapped holes, cross threading does not damage threads or plug or

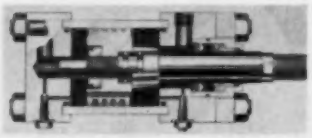
port. Loosening torque exceeds tightening torque. Made of Delrin acetal resin.

Specifications: Square-head sizes are ¼", ⅜", ½", and ¾". Hex-head sizes are ⅛" and ¼". For 3000-10,000 psi.
Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y.

Circle **311** on Time-Saver Card

HYDRAULIC CYLINDERS

Cartridge rod bearing has metal rod scraper, rubber wiper, and spring-loaded, multiple-vee packings. Can be removed with cylinder in place. Extra-long Meehanite bearing surfaces. Step-cut cast iron piston rings. Self-centering cushion compensates for side loads. Tie rods and piston rods are high-carbon

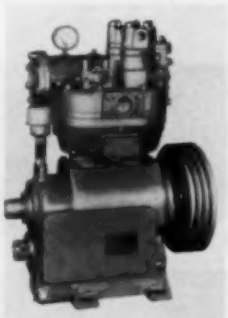


steel. Interchangeable, fully-adjustable cushion needle and ball check are flush-mounted. One-piece piston is of ductile iron.
Carter Controls, Inc., Lansing, Illinois.

Circle **312** on Time-Saver Card

HEAVY-DUTY COMPRESSORS

Two models use interchangeable parts on comparable sizes. Water-cooling increases efficiency. Gear-driven, rotary oil pump. Aluminum



pistons. Crankcase and cylinder are separate. Main bearings are adjustable, tapered roller bearings. All sheaves are grooved for latest design V-belts.

Specifications: 2-stage model LB is for pressures to 1000 psi. Capacities from 50 to 120 cfm. Single-stage model LA is for pressures to 125 psi. Capacities from 71 to 240 cfm.
Gardner-Denver Co., Quincy, Illinois

Circle **313** on Time-Saver Card

AIRLINE LUBRICATOR

To remove transparent bowl, press locking lever, twist bowl. Unnecessary to turn off air line. Cannot be taken off accidently—when bowl is unlocked, valve under locking lever is vented. This relieves all pressure in bowl.

Specifications: With one adjustment, lubricator injects fog into air

Continued on page 140

IN HYDRAULIC DESIGN

Use the IMO Pump for your high capacity requirements

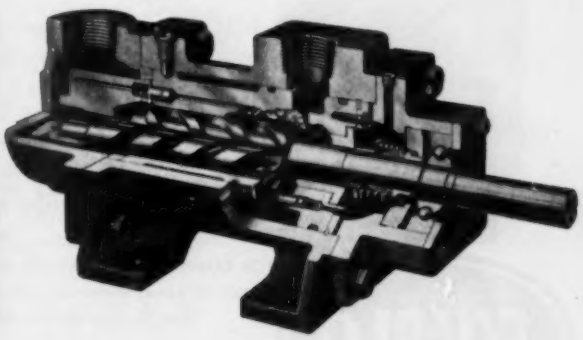
Big money, space savings—single IMO pump delivers up to:
3000 gpm @ 300 psi • 900 gpm @ 500 psi
400 gpm @ 1250 psi • 275 gpm @ 3000 psi

The De Laval IMO pump is unique. It may often replace two or more other type pumps in your design because of its high capacity. In the illustration shown here, the IMO pump is used to actuate a freight car unloader, designed by Straight Engineering Company. In addition to high capacities in a single pump, the IMO also gives you:

- Quiet operation—the proven pump for hydraulic elevators.
- High speed operation without sacrificing performance—ideal for 3500 and 1750 rpm motor speeds.
- Least pulsation of any rotary pump—ideal for machine tool applications.
- Dependable, long life operation—"the" pump for critical services on naval vessels.
- High suction lift capability—eliminates need for supercharging.
- Rugged design—nodular iron case utilized for pressures over 500 psi.
- Exceptionally high mechanical efficiency—means longer pump life.

The IMO has been time-tested and proven in the following applications: machine tools, presses, fan drives, pumping jacks, elevators, water level controls on dams, turbine governor controls, furnace controls, fire trucks—to rotate and raise ladders, and hydraulic systems for the U. S. Navy.

If you want more information on the versatile IMO pump, write for Bulletin 3200.



DE LAVAL **STEAM TURBINE COMPANY**
906 NOTTINGHAM WAY, TRENTON 2, N. J.

DL 333

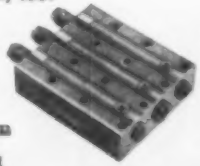
POSITIVE AUTOMATIC PRESSURE CONTROL?

CHECK YOUR REQUIREMENTS AGAINST FULFLO SPECIFICATIONS

- ✔ Screw or flange models
- ✔ Pressures to 500 pounds
- ✔ Pipe sizes to 3"
- ✔ Steel, cast iron or brass bodies
- ✔ Brass, steel or stainless trim
- ✔ All-steel for extra safety

FULFLO gives you what you want in safe, trouble-free and quiet operation for any hydraulic system. Shear-closing action eliminates chattering; sliding piston gives full flow opening; distinctive construction allows easy adjustment within the valve's pressure range or change of the pressure range.

Whatever your requirement . . . for O.E.M. use or replacement service . . . there's a FULFLO Oil By-Pass Relief Valve designed just right, built right and priced right, too!



NEED A "Special"?

FULFLO can engineer a special valve to your most exacting requirements. Examples of "specials" are shown in Data Book.

FOR EXTRA CONVENIENCE

Where frequent pressure setting adjustment is needed, install a FULFLO Hand Wheel Valve. Made in a variety of styles.

FOR COMPLETE INFORMATION, request a copy of the FULFLO Valves Mechanical Data Book with complete specifications and engineering data.

TRADE MARK "FULFLO" REG. U.S. PAT. OFF.

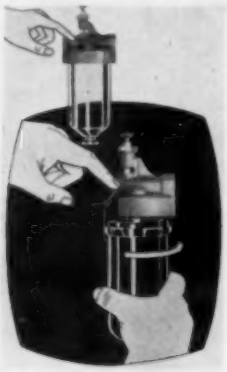
THE FULFLO SPECIALTIES CO., INC.

415 Fancy Ave. Blanchester, Ohio

Circle **59** on Time-Saver Card

NEW PRODUCTS

stream carrying as little as 1 cfm, up to line's full flow. Bowl holds 12 oz lubricant. In ¼", ⅜", and ½" female pipe threads. Height is



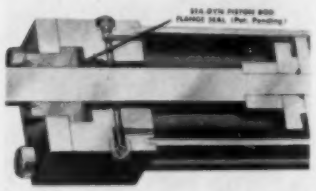
9-1/16". Width is 3½". For ambient temperatures to 120 F. For pressure to 150 psi.

Designation: Model 3014—*Wilkerson Corp., Englewood, Colorado*

Circle **314** on Time-Saver Card

AIR CYLINDERS

New rod flange seal simplifies and speeds assembly and field replacement. Rod flange seal and rod-



bushing sealing ring are one piece. Seals with pressure. Pressure-balancing ring at seal's base protects it against blow-out. Standard on Miller air cylinders.

Designation: Sta-Dyn seal—*Miller Fluid Power Div., Flick-Reedy Corp., Bensenville, Illinois*

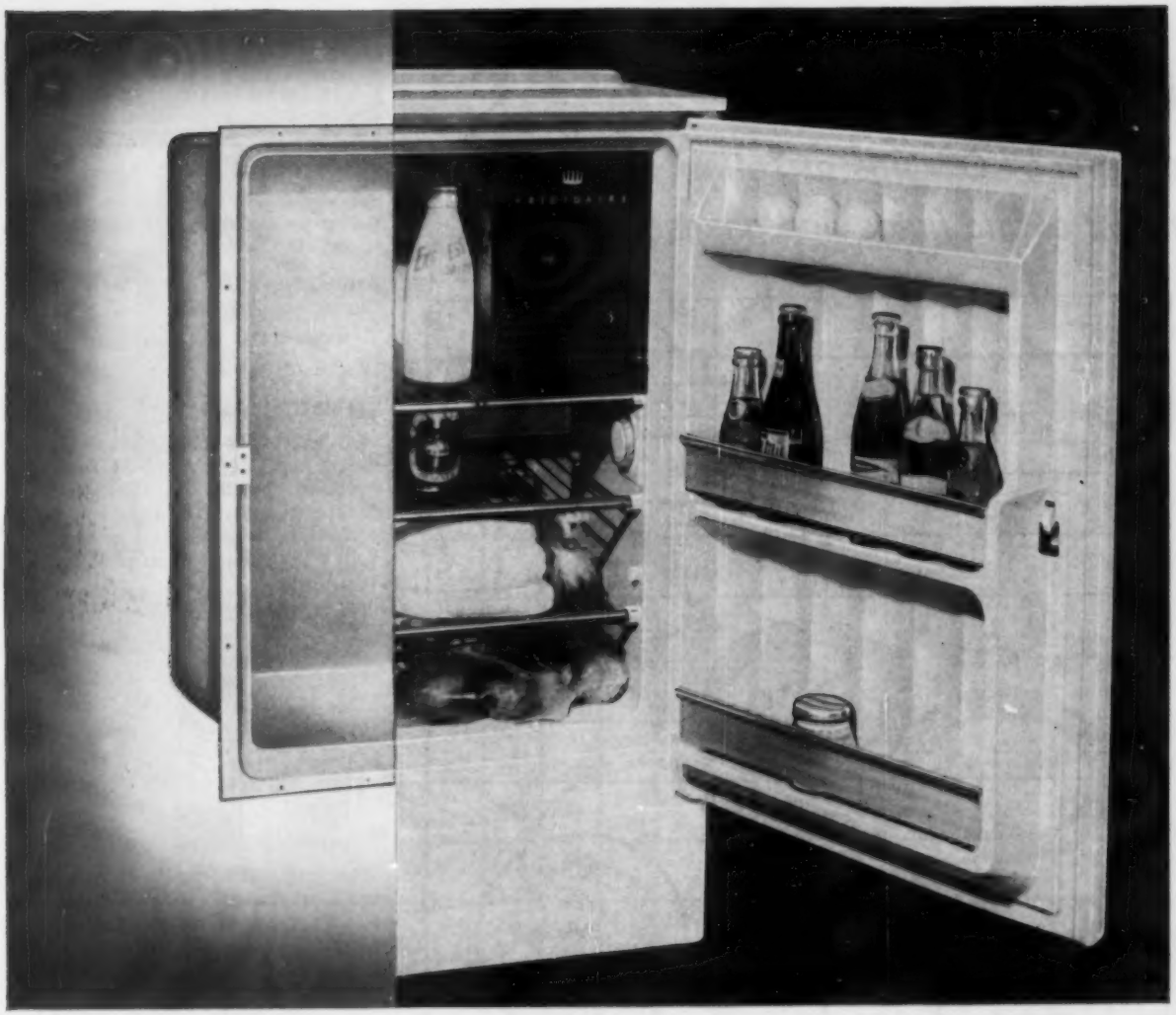
Circle **315** on Time-Saver Card

FLEXIBLE COUPLINGS

Shaft rating permits selection by shaft diameters. All working parts are heat-treated, high-tensile steel. Finished bore or taper-lock bushed types.

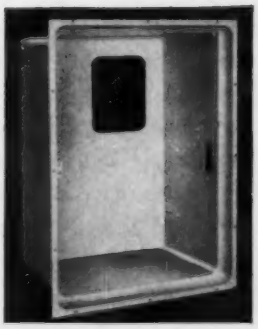
Specifications: 1155 shaft-diameter combinations. Finished bore cou-

Continued on page 142



PLASTICS

The liners of modern refrigerators are moulded complete in one operation in high impact polystyrene. The injection moulding machines used in these operations are, it is claimed, the biggest built in the United Kingdom, and employ Vickers-Armstrongs "VSG" variable delivery pumps. Developments in the Plastics Industry continue at an ever increasing tempo, with new methods and machinery continuously being evolved to improve manufacturing standards and to increase the scope of moulding techniques. The use of these pumps in this highly specialised industry is a further example of the many and varied applications of "VSG" equipment which have been serving modern industry for over fifty years.



Moulded for Frigidaire by Ekco Plastics on Windsor AP335 machine.

'VSG'

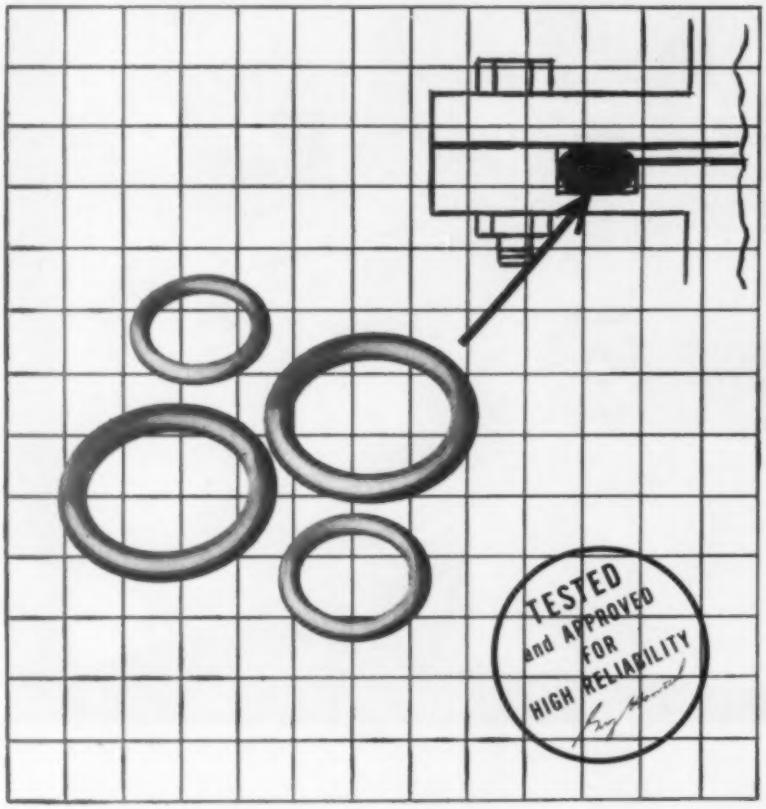
Regd Trade Mark

SERVING MODERN INDUSTRY

VICKERS-ARMSTRONGS (ENGINEERS) LTD VICKERS HOUSE BROADWAY LONDON SW1

R/M CAPABILITY

develops "O" rings of Teflon to resist exotic fluids and gases*



Here are compact, double-acting seals that really fit into compact designs. They are much more than just space-savers. They are resistant to extrusion, have an extremely low coefficient of friction that reduces breakaway effort on slow-moving reciprocating and rotary equipment. They have broad chemical resistance, have a servicable temperature range from -100°F to +500°F and therefore are adaptable to a wide range of applications. They are generally recommended for use as static seals.

For more information about these versatile, tough 2-way seals, write for R/M's Plastic Products Catalog.

*Du Pont trademark for its fluorocarbon resins

R/M **PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **130** on Time-Saver Card

NEW PRODUCTS

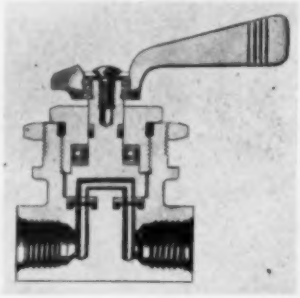
plings are also supplied for reboring for shafts in any diameter from 7/16" to 6 1/8"

Designation: Hi-Cap—*Diamond Chain Co., Indianapolis*

Circle **316** on Time-Saver Card

SELECTOR VALVE

Miniature valve has micro-finish sliding seals. For air and oil. Seals are wear-compensating. They wipe surfaces clean as they move across ports. Line pressure aids sealing. Body is forged aluminum alloy. In-



ternal parts are stainless steel. Handle designed for panel clearance.

Specifications: For 3000 psi. Maximum panel thickness is 5/16". Measures 2" x 2". Has 2, 3, and 4-way porting. Ports are ⅜" and ¼" internal straight thread (AND-10050), and internal pipe thread.

Designation: Mini-Lo-Torq—*Republic Mfg. Co., Cleveland*

Circle **317** on Time-Saver Card

HYDRAULIC CYLINDERS

All steel. All standard mountings. Clevis-mounted model has self-aligning spherical bearings at both

pin connections. Wide selection of rod sizes and cushion controls.

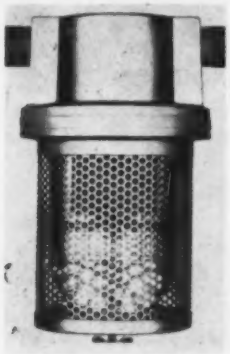
Specifications: For operation at 3000 psi. Factory tested at 5000 psi. Bore sizes 1 ¾" to 12".

Designation: 3H Series—*Pathon Mfg. Co., Cincinnati*

Circle **318** on Time-Saver Card

BOWL GUARDS

For plastic bowl on Crown filters and lubricators. Made of heavy-gage, perforated steel. Hole size

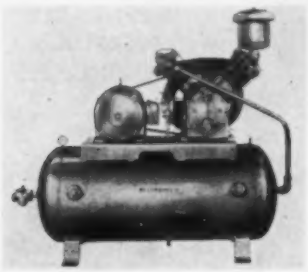


and pattern give safety and visibility. Guard does not touch bowl. Overall dimensions of filters and lubricators do not increase when bowl guards are added. Guard is integral part of bowl retaining ring. It can't be left off. Available on new units, or in kits for units in service.
Hannifin Co., div. Parker-Hannifin Corp., Des Plaines, Illinois

Circle **319** on Time-Saver Card

2-CYLINDER COMPRESSOR

Model 5YC compressor has automatic unloading system for starting. Allows drive motor to reach full



speed before compressor begins to pump air. Protects against operation with low oil. Inlet valve unloaders for constant-speed operation have fewer parts, operate more efficiently.

Specifications: Operating pressures are 125, 175, and 250 psi.
Le Roi Div., Westinghouse Air Brake Co., Milwaukee

Circle **320** on Time-Saver Card

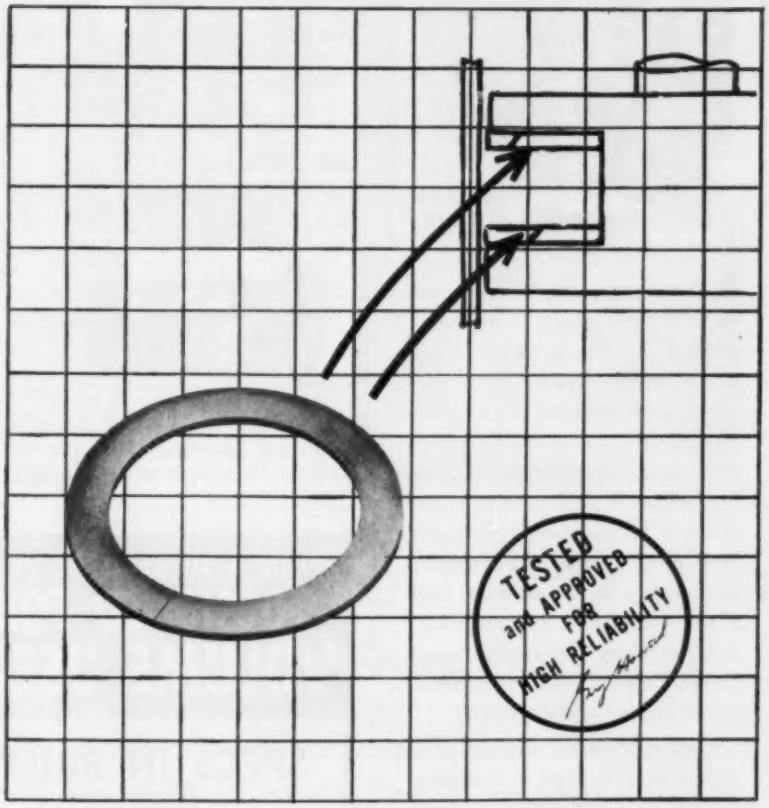
FLOW CHECK SNUBBER

Prevents escape of harmful fluids if pressure lines rupture. Prevents transmission of transient line surges or pulsations. Isolates instruments

Continued on next page

R/M CAPABILITY

develops back-up rings of Teflon to prevent "O" ring extrusion at pressures up to 3000 psi*



Here are back-up rings that eliminate the major disadvantage of "O" rings. They positively prevent extrusion of the "O" rings under pressures to 3000 psi, plus these benefits:

- *Low coefficient of friction*
- *Broad chemical resistance*

Precision machining by R/M assures accurate fit . . . consistent performance. Write for your copy of the R/M Plastic Products catalog. It gives complete information on R/M Teflon back-up rings and "O" rings.

**Du Pont trademark for its fluorocarbon resins*

R/M **PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **173** on Time-Saver Card

ECONOMICAL COOLING OF GASES and COMPRESSED AIR

NIAGARA *Aero* AFTER COOLERS

● Cooling gases or cooling and removing moisture from compressed air, the Niagara *Aero* After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point close to the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

Cooling-water savings and power-cost savings in operation return your equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight and installation labor and in the expense of upkeep.

Niagara *Aero* After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130

NIAGARA BLOWER COMPANY
Dept. AH-8, 450 Lexington Ave.
NEW YORK 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada

Circle **113** on Time-Saver Card

NEW PRODUCTS

from fluid. Responsive to small pressure changes. Reaches full equilibrium in 2 to 3 sec. Can't clog or plug, because snubber is assembled into device's sealed system. Works with instruments actuated by bourdon tubes or diaphragms.

Specifications: Accurate readings from 100 to 5000 psi.
Chemiquip Co., New York

Circle **321** on Time-Saver Card

AIR CLAMPS

Spring-return clamps have alloy bodies. Piston rods are ground and

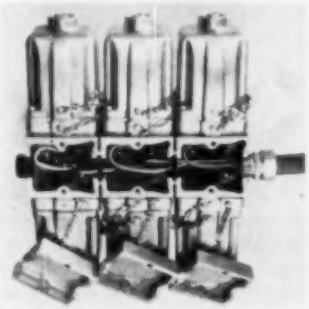
polished stainless steel. Horizontal or vertical mounting. U-cup piston packing. Oil-type bearing.

Specifications: ACM-110 has 1 ⅜" bore, 1" stroke. ACM-120 has 1 ¾" bore, 2" stroke. ⅛ NPT inlet ports 1:1 ratio of force to air pressure.
Allenair Corp., Mineola, N. Y.

Circle **322** on Time-Saver Card

SOLENOID VALVES

Five valves can be mounted on manifold. Single-solenoid spring-re-



turn, or double-solenoid. 2, 3, or 4-way. 2 or 3-position. For air and oil. Seven spool types. Built-in electrical junction box. Easy installation of wiring. One valve can be removed from manifold without disturbing wiring of adjacent valves. O-rings give vapor-tight

Continued on page 146

FLUID & AIR CONTROL VALVES
DESIGNED FOR VOLUME USERS

★ LOW-COST
★ DEPENDABLE
★ VERSATILE
★ TROUBLE-FREE

SPECS IN BRIEF...

SIZES: ⅛" to ¾" NPT.

PRESSURE RANGES: Up to 2000 PSI for brass and aluminum. Up to 5000 PSI for steel or stainless.

MATERIALS: Stocked in brass and steel. Available in stainless, aluminum, and other alloys to order.

FEATURES: Low initial cost and less maintenance. High flow-to-size ratios. "Straight-thru" principle cuts friction loss and clogging. Easy to install.

USED BY the biggest names in American industry . . . and in military applications.

DESIGN MANUAL
Complete specifications and design aids in handy file-size folder is yours on request. Write on letterhead or use inquiry card.

TRUE-FLO® VALVE company, inc.
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'Straight-thru' design for highest flow and dependability. Free-moving ball principle.

FLOW CONTROL VALVES

Adjust flow rate (in stepless ranges) with common screwdriver before, during, or after easy installation.

DUAL CONTROL VALVES

Unique . . . controls flow in both directions independently! True 2-way control for little more than the cost of one flow control valve.

Circle **156** on Time-Saver Card

READER-PROFIT is the basic ingredient of a successful publication. When a magazine produces profitable returns on readers' time, it will also repay its advertisers' investment handsomely. This month marks our thirtieth anniversary. These 30 years have seen many changes: our publications have grown from one to 13, our employment from two to nearly 200, our aggregate circulation from less than 10,000 to half a million. But our basic publishing goal remains the same. We will continue to devote our efforts towards producing a profit for the man on whom our success depends: the reader.

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NEW PRODUCTS

seal. Solenoids have manual actuators.

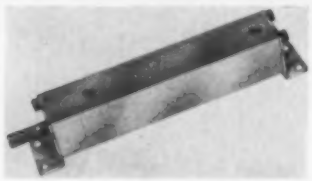
Specifications: ¾" valves mount on 2 ¾" centers.

Designation: Hi-Cyclic—*Beckett-Harcum Co., Wilmington, Ohio*

Circle **323** on Time-Saver Card

AIR CYLINDERS

Double-acting cylinders are square on the outside. Mounting holes can



be drilled and tapped along length of barrel. Barrel is seamless, extruded aluminum. Cylinder heads are pressure-cast aluminum. No tie rods. Interchangeable attachments for foot, flange, clevis, and trunnion mountings. Piston rods are stainless steel. V-block piston and rod seals. Build-in rod wiper is interchangeable with rod seal.

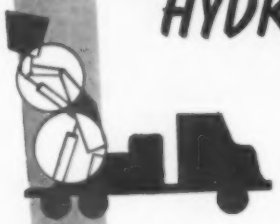
Specifications: Diameters are ¾", 1", 1½", 2", and 3".

Designation: Square Barrel Class 7 —*Galland-Henning Nopak Div., Milwaukee*

Circle **324** on Time-Saver Card

ON THE JOB...

with CROSS HYDRAULIC CYLINDERS



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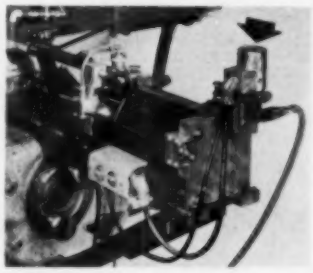
Circle **42** on Time-Saver Card

CIRCUIT-HOLDER VALVE

4-way solenoid valve has built-in circuit holder. Simplifies wiring—



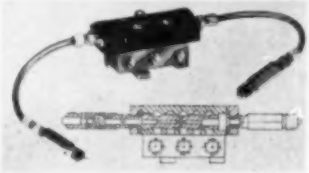
eliminates relays and relay circuits. Controls cylinders on tooling setups.

Barksdale Valves, Los Angeles

Circle **325** on Time-Saver Card

PILOT AIR VALVE

4-way, 5-ported. Line pressure goes through drilled core to both ends of spool. Thrusts are balanced. Bleeding air from either chamber shifts spool. Double-bleeder valve



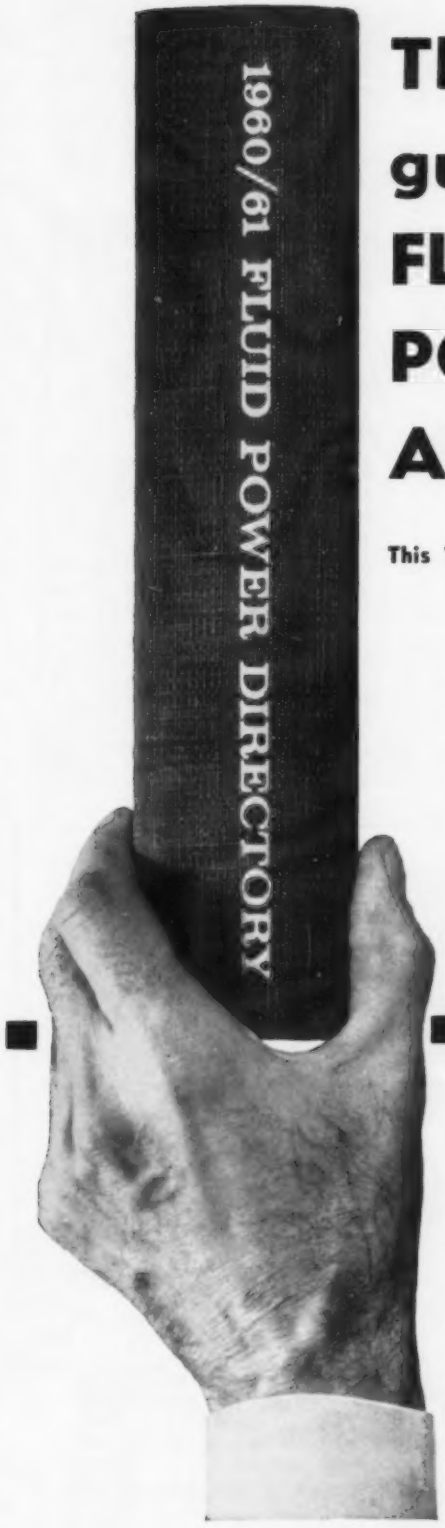
is for momentary operation. Single-bleeder valve is for maintained operation. Can be used for sequencing or remote control. Small bleeder actuators have hardened ball nose plunger and can be mounted anywhere. They can be used as 2-way NC valves.

Specifications: ¼" valve can operate at less than 5 psi line pressure. Capable of over 1000 cpm.

Alkon Products Corp., Hawthorne, N. J.

Circle **326** on Time-Saver Card

Continued on page 148



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America's First cO-Mpact Cylinder

INTERNAL KEY
TIE-RODLESS-TYPE SERIES 101A

Air 150 psi—Hydraulic up to 1500 psi
Fits where others won't
Meets JIC Standards, Bulletin 101A

This original space-saving cylinder is the most compact, streamlined and versatile cylinder available. It requires one-third less installation space and has a greater ratio of power to its size and weight than tie-rod-type cylinders with the same bore and psi rating. In addition, the ports can be rotated independently to any convenient location. It is easier to service. And by using a majority of standard parts and one or two semi-standard parts, this component gives you the advantage of special cylinders that do a better job at a nominal cost.

This compact unit has the lowest coefficient of friction. It is designed right to seal right . . . to make full-power starts on thrust and return strokes . . . to maintain perfect rod alignment . . . and cushion piston shocks. End plugs are tapped for universal mounting.

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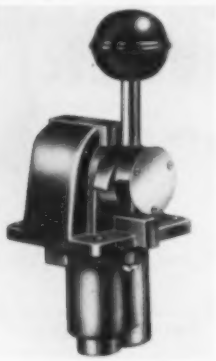
NEW PRODUCTS

DIRECTIONAL AIR VALVE

For panel mounting. Single-unit, 3-way valves are NO or NC. Double-unit, 4-way valves provide three types of operation. All-purpose operating cam may be rotated to



change from one function to another. Hardened, sintered steel cams. Synthetic rubber seats and seals resist oil. Internal parts are totally enclosed.

Specifications: For 250 psi. Temperature range from −40 to 200 F.

Designation: Pilotair—*Westinghouse Air Brake Co., Wilmerding, Pa.*

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AMPLIFIER

Operates 2-stage electrohydraulic servovalves. Produces a differential current in torque-motor coils proportional to voltage applied at amplifier input. Two regulated and stabilized power supplies. Variable-frequency (200-600 cps) dither signal generator reduces effect of friction in servosystem's mechanical components.

Specifications: Requires 115 vac, 120 w. Nominal resistance of servovalve's torque-motor coil is 1000 ohms, each side. Quiescent output current is 5 ma. Maximum differential output current is 8 ma. Frequency response with feedback is 0-1000 cps. Dither amplitude is 0-3 ma. peak to peak.

Designation: Model E/DCA-10 type 100 A—*Eastern Industries, Inc., Hamden, Conn.*

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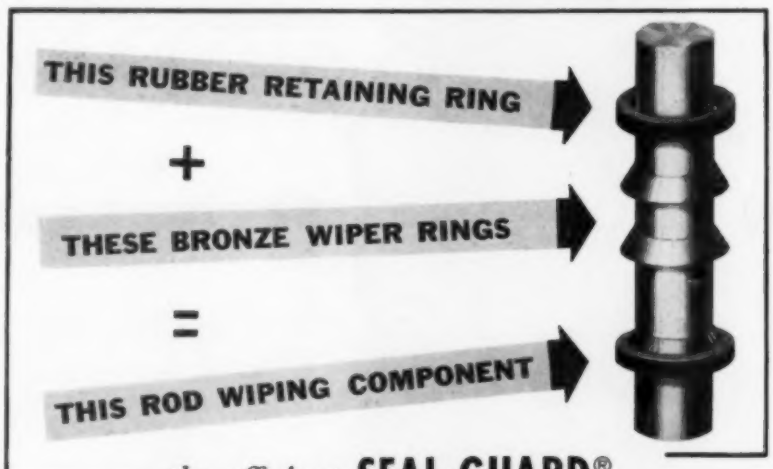

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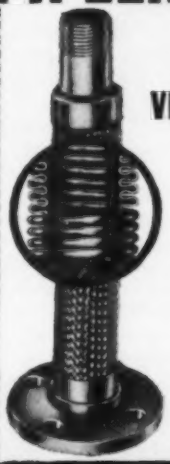
CALM Jittery PIPELINES



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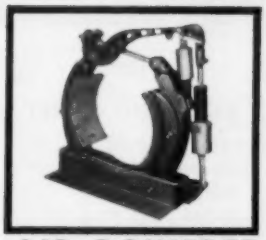
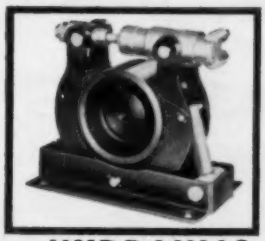
with Wagner





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Norm. Open-Closed
2 Pos. Spr. Ret.

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2 Pos.
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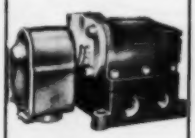

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2 Pressure
Sub-Base Mtd.
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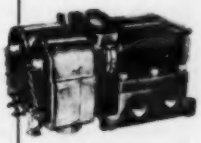

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Standard solenoid pilot coils for continuous operation are furnished for 115 or 230 volts (60 cycles AC). Other voltages and frequencies including direct current available with special coils. Where moisture is problem molded waterproof coils are available.

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Open To Exhaust
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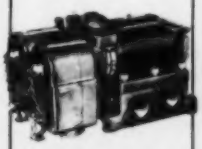

Sub-Base Mounted

4 WAY
5 PORT
Twin Solenoid Pilot
2 Pressure
3 Pos. Spg. Cent.
Cyl. Ports
Open To Supply
In Neutral

Some Exclusive Territories Still Available

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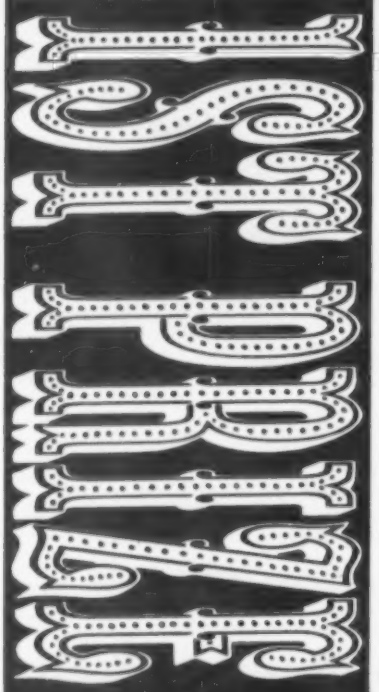
ANNOUNCING



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USEFUL LITERATURE

Continued from page 62

ROTATING SHAFT SEALS

Six types: O-ring, cartridge, grommet, boot, bellows, and labyrinth. Charts of temperature, speed, and pressure limits of each type. Bulletin explains construction and operating features. Dimension charts. Drawings of typical designs. Bulletin shows mating rotors. 34 pp. *Cartriseal Corp., Lincolnwood, Illinois.*

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For hydraulic or pneumatic reciprocal motion. Resist heat and synthetic fluids. Hold shape and size. Cannot dry or harden. Low friction. Walls flare a precise measurement beyond nominal cylinder diameter. Lip interference loads cup. Outward pressure against cylinder wall. Clearance at heel and use of single-lip packing reduce packing contact area. Two types: fabric coated with synthetic rubber, and synthetic rubber. 45 sizes have OD's from 1" to 12". Heights from ⅜" to 1". Wall thicknesses from ⅛" to 3/16". For temperatures to 600F. Bulletin K-260 has drawings, size tables, and design tips. *Greene, Tweed & Co., North Wales, Pa.*

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PRESSURE GAGE

Has 360-deg linear dial. Movement calibrated to dial with accuracy of ±0.15%. Can easily be calibrated to any stock dial of same range. 12" dial gives equivalent scale length of 16" 270-deg dial. Pointer movement is balanced at mid-scale, zero, and full-scale. Pointer motion describes a sine wave, with error equal but of opposite sign for equal increments on either side of mid-scale. Since zero, mid-scale, and full-scale are on a straight line on the dial, the dial can be shifted vertically to flatten the sine wave. This eliminates errors between zero and mid-scale, and between mid-scale and full-scale, without affecting ac-

Continued on page 152

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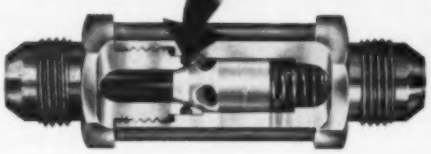
Flexible Seal Seat*



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- LONG LIFE! EASY CLEANING!
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Pressures: Vacuum to 30,000 psi
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Sizes: ⅛" thru 1" in pipe threads and many types of tube ports
Materials: Carbon Steel, 4140, Monel, Aluminum, Brass, and various types of Stainless Steel
Packings: Teflon, Asbestos types, and other materials
Mountings: Regular and Panel
Dealers in all major cities

SOFT SEAT NEEDLE VALVE — Vacuum to 6,000 psi, —100°F to +500°F
FAST SHUT-OFF NEEDLE VALVE Cam action lever handle, 10,000 psi
REMOTE CONTROL NEEDLE VALVE Holds 10,000 psi with 50 psi on diaphragm
CRYOGENIC NEEDLE VALVE

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DRAGON ENGINEERING CO., INC.
Since 1946 P.O. BOX 185, NORWALK, CALIFORNIA

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OUTSTANDING SUCCESS WITH THE PRE-SPIROFLEX METHOD OF HIGH PRESSURE HOSE MANUFACTURE

- EXTREMELY HIGH PRESSURES ARE OBTAINED ALONG WITH SUPER-FLEXIBILITY.
- THE INDIVIDUALLY CONTROLLED HIGH TENSILE WIRES REMAIN INERT AFTER WRAPPING.
- "STAY-PUT" COVERS ALLOW EASY ASSEMBLY OF FITTINGS.
- LONGER HOSE LIFE DUE TO LESS COVER FRICTION.

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B & F CARTER & CO. LTD.

ALBION WORKS
BOLTON 9, ENGLAND

ELECTRIC CABLE, BRAIDING & WIREROPE MACHINERY OF EVERY DESCRIPTION
REPRESENTATION IN THE U.S.A.
PRECI-MATIC CORP., 60 E. 42ND. ST., NEW YORK 17, N. Y.
GRAMS: "BRAIDERS BOLTON"

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USEFUL LITERATURE

curacy at zero, mid-scale, and full-scale. Change in elastic modulus of Bourdon tubes is zero over -50 to 150 F. Dials for pressures from 0-60 psi to 0-15,000 psi. Mirror finish under pointer minimizes parallax error. Bulletin M-28A *Martin-Decker Corp., Long Beach, Calif.*

Circle **413** on Time-Saver Card

MUFFLERS

For air motors and vacuum pumps, when blast enters muffler, directional vanes divide it into smaller streams. These pour into an obstruction-free expansion chamber, which reduces their initial intensity. They bound off its perimeter and meet at a common collision point. Collision reduces velocity and pressure. The harmless waves which remain filter through muffler's hyperporous disseminator shell. There is no internal packing, stuffing, or obstructing baffles. Working pressure is restricted only slightly. Prevents troublesome air flow and afterblasts. Bulletin has photos and illustrations. Diagrams of principles of operation. Graphs, specifications. *Allied Witan Co., Cleveland.*

Circle **414** on Time-Saver Card

STOCK CYLINDERS

Models, dimensions, strokes, and prices of air and oil cylinders, boosters and tanks. Mountings include tie rod, lug, flange, flush side, trunnion, and clevis. Variations include rotated ports, rotated cushion adjustments, rod extensions, mixed mountings, piston-rings and Teflon piston cup seals. Air cylinders in bore sizes from 1½" to 14". For 750 psi. Model J hydraulic cylinders in same bore sizes, for 2500 psi. Model H hydraulic cylinders have bores to 8". For 5000 psi. *Miller Fluid Power Div., Flick-Reedy Corp., Bensenville, Illinois.*

Circle **415** on Time-Saver Card

RING SEALS

Tetraseals replace O-rings from 3/16" to 15" ID. Use same groove. Extremely close tolerances on rectangular cross-section. No joints or laminations. For almost all static, and some dynamic, applications. 12-pg brochure has size tables. *Goshen Rubber Co., Goshen, Ind.*

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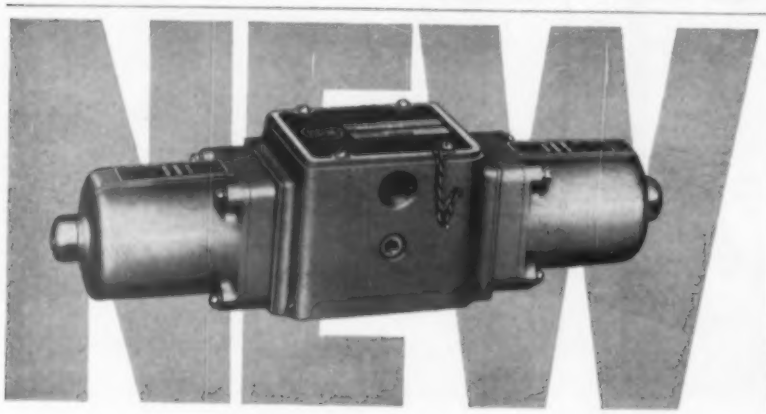
MINIATURE PUSHBUTTONS

Oiltight bushbuttons offer same operating and functional units available in heavy-duty, models with space savings of 40-60%. Operators include standard (with or without guard) and mushroom-head pushbuttons, resistor and transformer-type illuminated pushbuttons, resistor and transformer-type indicating lights, and push-to-test indicating lights. Separable nameplates. Install with ordinary wire-crimping tool and pliers. Minimum centerline spacing is 1¾" horizontal and verticle. Pressure-type terminations snap on, don't jiggle loose to cause intermittent open circuits. Encapsulated transformer in illuminated units has isolated secondary windings. Operators available with one NO and one NC contact, or with two each. Multiple oil seals. Bulletin GEA-7127 has photos and dimensioned drawings of each operator. 10 pp. *General Electric Co., General Purpose Control Dept., Bloomington, Illinois.*

Circle **417** on Time-Saver Card



H-P-M ¼" four-way pilot valves, single or double solenoid

The new H-P-M ¼" pilot valve is interchangeable with industry standards, handles 9 gpm at 3000 psi, single or double solenoid types available. These are quality valves for long, heavy-duty service at a price comparable with ordinary solenoids. Subplates available for standard mountings.

H-P-M pilot valves feature totally sealed, oil-immersed solenoids for long life and maintenance free operation — virtually millions of extra cycles. Immersed in oil, the solenoid operates cooler, shock and pounding is lessened, normal problems experienced with air gap type solenoids are eliminated. Oil-immersed solenoids have bayonet type connections; service is simplified with no wire connections to break.

AVAILABLE FROM STOCK FOR IMMEDIATE DELIVERY.
Send for new specification sheets, today.

H54

THE HYDRAULIC PRESS MFG. COMPANY
A Division of Koehring Company, Mount Gilead, Ohio, U.S.A.

Circle **81** on Time-Saver Card

Circle **150** on Time-Saver Card

Accurate, Automatic temperature control

OF HYDRAULIC AND HEAT TRANSFER FLUIDS

Peak performance of hydraulic equipment is assured by the precise, dependable oil temperature control maintained by the Sterlco Temperature Control Valve, Series 150E. It's completely automatic, self-contained, compact and low cost . . . operates in any position. Write for details.

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Temperature Control Valve
Series 150E

Leaders in temperature controls since 1916

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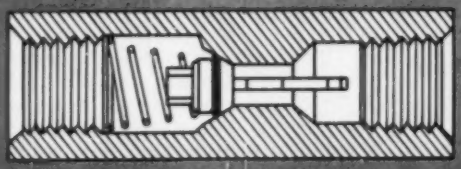
5202 West Clinton Avenue Milwaukee 23, Wis.
Industrial Control Division

Lowest Priced Highest Quality

Soft Seat CHECK VALVES



. . . with positive sealing

- Low Pressure Drop — large flow passages and straight-line flow assure minimum pressure drop.
- Excellent Flow Characteristics — poppet is guided to assure positive sealing and prevent cocking. In-line flow creates a self-cleaning action.
- Long Service Life — positive poppet stop prevents damage to long-life stainless spring.
- Rugged — one piece leakproof body.
- Safe — not affected by foreign particles.

- For oil, gas vacuum, water and other fluids.
- Pressures: Brass to 2,000 psi Steel to 5,000 psi Stainless Steel to 5,000 psi
- Sizes: ⅛" thru 1" dry seal threads AND-10050-4 thru AND-10050-16 Ports

Write for detailed literature.

THE MANATROL Corp.
2372 W. 7th St. • Cleveland 13, O. • CH 1-0575

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GENERAL Industrial FILTERS

AF-500 and AF-500C CLEANABLE WOOL FELT

Famous for its line of fluid filters, the General Filters' 500 series is highly representative of Generals' recognized efficiency. The model illustrated, built in two sizes, incorporates a *cleanable* wool felt element and is especially recommended for economical protection of hydraulic oils, lubricating oils, hydrocarbon liquids, paints and varnishes. Lifetime iron and steel construction. Install with inlet at top or bottom. Wool element with wire screen core to prevent collapsing, 5 or 15 microns, cleans easily in any suitable solvent.

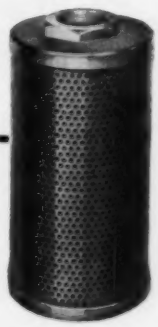
AF-500-X SERIES with THROWAWAY Cartridge

For quick filter changes with minimum machine shutdown the "X" series is a proved performer. Choice of three phenol resin-treated pleated paper *throwaway* cartridges: 5, 15, or 35 microns. BIG filtering area — 3000 sq. in. — ideal for lowest cost performance.

AF-500 CM and CMS HIGH PRESSURE

Heavy-duty model for working pressure up to 1000 psi. Available in two sizes. Same cleanable wool felt element used in AF-500 filter.

3000 SERIES SUMP TYPE FILTER



Five sizes from 8 to 50 gpm. Monel mesh screen pleated element for submerged installation. Can be installed individually or in multiples of two or more for greater capacity. 100-mesh standard — other sizes available.

10 MONEY SAVING MODELS

General Filters' wide range of fluid filters provide maximum service and performance for practically any industrial application. Meet J.I.C. standards. Write for information and prices.

GENERAL FILTERS, Inc.

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In Canada: Canadian General Filters, Ltd.
39 Crockford Blvd., Scarborough, Ontario

Circle **65** on Time-Saver Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Charles H. Smith to assist president of WABCO

Charles H. Smith has been made special assistant to A. King McCord, president of Westinghouse Air Brake Co., Pittsburgh. Smith's work will be connected with WABCO affiliates in France, Germany, Italy, Belgium, Switzerland, and Spain. He retired from the Navy in 1959, as a Rear Admiral.

Parker-Hannifin appoints two

Donald W. Lange has been promoted to sales engineer in the Chicago office of Parker-Hannifin Corp. He will handle industrial hydraulic and pneumatic products. Lange was assistant product sales manager on cylinders with Hannifin Co. div. He joined Hannifin in 1952. Donald L. Wilson will represent Parker Seal Co. in western Ohio and eastern Pennsylvania. He was with Dayton Rubber Co.

Lange

Anderson

Anderson heads engineering for new group at Crane Co.

Dr. Jack S. Anderson is director of engineering for the newly formed Systems and Controls Group of Crane Co. The group is composed of Hydro-Aire Co., Burbank, producer of specialized hydraulic, pneumatic, electrical, and industrial controls. Chapman Valve Co., Indian Orchard, Mass., developer and producer of heavy valving, and Swartout Co., Hooksett, N. H., manufacturer of electronic and electro-mechanical controls. Anderson joins Crane after six years as vice president of engineering for all subsidiaries of Royal Industries, Inc. He will coordinate product lines and direct the systems capability for the group. He holds patents in guidance and control systems for underwater missiles and a numerical control system for tape programming in machine tool automation.

Clarkson to manage Cuno sales promotion

Frederick H. Clarkson, Jr., has been made sales promotion manager of Cuno Engineering Corp., Industrial Div., Meriden, Conn. He was advertising manager, Taft-Pierce Mfg. Co., Woonsocket, R. I.

Jean Mercier will lead new hydraulics company

Jean Mercier is president of a new firm, Olaer Products, Inc., Westbury, L. I. The company will supply engineering, service, and prototype facilities in the fluid power and electrical fields. Mercier is president of Olaer France, S. A., and a consultant to Greer Hydraulics, Inc. His inventions include the piston accumulator in 1934 and the bladder accumulator in 1938. He holds more than 200 patents in the United States and more than 1000 in other countries. The air-suspension used on most American buses, trucks, and automobiles is one of his developments. Stephen Polanski, vice president and general manager of Olaer Products, was operations manager of Greer.

Denison names McCarthy field engineer

Denison Engineering Div., American Brake Shoe Co., Columbus, Ohio, has appointed Ronald J. McCarthy as a field engineer. He will work out of the division's Midwest regional office, Chicago. His territory is Wisconsin, Minnesota, the Dakotas, and Upper Michigan.

McCarthy

Chao

Chao heads Vickers R & D

Dr. W. Wai Chao has been appointed director of research and development for Vickers, Inc., Div. Sperry Rand Corp., Detroit. Before joining Vickers as research chief last year, he directed engineering of the second-stage liquid rocket engine for the Discoverer program, and altitude-control rocket systems for Project Mercury and the X-15 airplane.

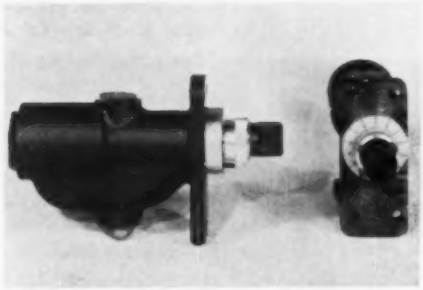
New fluid power consultants

The R. E. Raymond Co., Zanesville, Ohio, recently organized by R. E. Raymond will specialize in fluid power applications. Formerly with Racine Hydraulics & Machinery, Inc., and Simplex Engineering Co., Mr. Raymond offers valuable experience in designing in advanced hydraulic systems and components.

Continued on page 156

Circle **57** on Time-Saver Card

NEW pressure compensated LOW FLOW rate regulator



controls Flow as low as 2 cubic inches per minute.

Accuracy of ±10% over a pressure differential of 1000 psi at 2 GIPM.

Especially good for machine tools, air-oil cylinders, jet engine starters, or anywhere a low rate of oil or fuel flow must be controlled accurately.

Designed for panel mounting on test stands or bracked mounted in pipe lines.

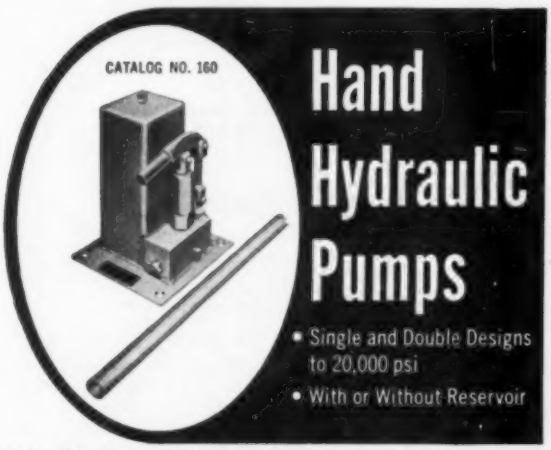
Built-in check valve provides free flow in reverse direction.

Adjustable between 2 and 90 cubic inches per minute.

Write for illustrated circular with blueprint.

FLUID POWER ACCESSORIES, INC.

P. O. Box 64, 2051 Railroad Avenue • Glenview, Illinois



160 cubic inch reservoir with 8"x 8" base plate and 18" long handle.

Available with optional size pistons ⅜", ½", ¾", 1" and 1½".

We specialize in the manufacture of hand pump units which operate in temperatures from −65° F. to +160° F. and with any capacity reservoirs required. Pumps can be furnished on special order with custom seals to handle various aircraft types of fuels such as Pydraul, Skydrol, Oronite, etc.

The single pump with ½", ¾", 1" or 1½" piston is now available in stainless steel.

for additional information write:

WILLIAM S. PINE

hydraulic hand pumps for 1001 uses

1635 East 22nd St., Los Angeles 11, Calif.

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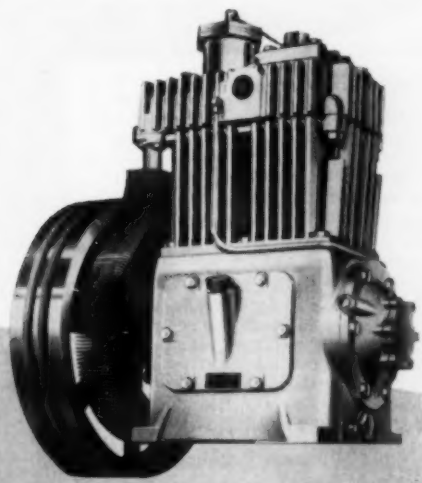
1 more good reason to think about *Quincy*

CUSHIONED STEEL VALVES assure extremely quiet operation for QUINCY COMPRESSORS. Each valve and seat is a separate assembly that can be removed for inspection without disturbing the other valves.

Designed by engineers who have pioneered air compressor advances for 40 years, each QUINCY is built to provide maximum service efficiency and long life. Cushioned steel valves are only 1 reason for QUINCY'S outstanding performance. Lynite connecting rods, automotive type pistons, Safe-Q-Lube pressure lubrication and Loadless Starting all contribute their functions and quality to the overall performance of QUINCY COMPRESSORS. The point is simply that you can count on a Quincy — for *years*. CHECK THE "Q-LINE" NOW — a complete range of industrial models for all applications.



Quincy COMPRESSORS

QUINCY COMPRESSOR CO., Quincy, Illinois

Makers of the World's Finest Air Compressors

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POST SCRIPTS OF INDUSTRY

Union Carbide Silicones Div. appoints nine

Union Carbide Corp.'s Silicones Div., New York, has appointed J. C. Malone assistant to the general manager. He was assistant superintendent of the Institute, W. Va., plant of UCC's Chemicals Co. C. T. Schieman, Jr., was made general sales manager of the division, and P. S. Manchester, assistant general sales manager. R. S. Wishart is the new manager, product marketing. Dr. T. F. Hart is product manager of fluids, and J. H. Lorenz, product manager of resins and water repellents. Three changes were made in the field sales group. T. J. Fontelieu, Jr., is eastern region manager. F. S. Phinney is southern region manager. C. F. Tripp is region product manager, eastern region.

Capital

HYDRAULIC FILTERS

for Hydraulic and Oil Re-circulating Machinery

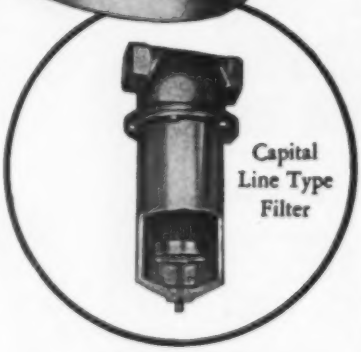
Capital Hydraulic Filter Units are smaller than ordinary filters but with filtering capacity equal or superior to many larger filters. Small size permits greater latitude in design, particularly where space is restricted.

Capital Filter Units are designed with one-piece construction — no screws or nuts to work loose and be lost or mislaid. Simple and easy to clean by any method.

Made from specially designed woven Monel wire, with narrow corrugations presenting the greatest filtering area. Monel support supplies extra sturdiness.

Capital Filter Units are made in 4 Types:

- **MONO-BILT 60 Mesh All Stainless Steel (Sump type).**
- **MONO-BILT Standard All Stainless Steel**
- **MONO-ECONO Mono-Bilt with Monel Metal Insert and Cadmium Plated Top and Bottom.**
- **LINE TYPE with Aluminum Housing and Mono-Bilt, one Piece Filter Unit.**



Capital Line Type Filter

Built from Monel Metal they are impervious to rust and corrosion.

CAPITAL ENGINEERING & MFG. CORP.

5836 SOUTH ASHLAND AVENUE, CHICAGO 36, ILLINOIS

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Kellerman promoted to major post by Bendix

The Bendix Corp. promoted Karl F. Kellerman assistant to the Executive vice president. Kellerman will assist in the expansion of Bendix commercial & industrial activities at both divisional and corporate levels. Prior to joining Bendix in 1955, he was president of Kellerman & Co.

American Sealants names Patlovitch

Ted Patlovitch was named representative for American Sealants Co., Hartford, Conn. His territory will include New Jersey, Eastern Pennsylvania, Delaware and Maryland.

Patlovich

Patterson

Patterson appointed sales engineer

C. E. Rucker, president of the Rucker Co. has appointed Wayne D. Patterson sales engineer for the company's Los Angeles office.

Dowty appoints four

Dowty Group Ltd., Cheltenham, England, announced the following appointments: F. Bastow is Managing Director of Dowty Seals Ltd. C. F. Porter and K. G. Ware are named to the Board of Dowty Mining Equipment Ltd., and C. N. King is appointed to the Board of Dowty Hydraulic Units Ltd.

Harter to manage Vickers' district office in Houston

Vickers, Inc., Div. Sperry Rand Corp., Detroit, has named Donald R. Harter district manager of its Houston office. He will be in charge of sales and service for Vickers industrial and mobile hydraulics. Harter joined the firm in

1953. He was an application engineer in the Cleveland office.

Harter

Alaback

Alaback to promote sale of Young's coolers, condensers

Young Radiator Co., Racine, has named Lloyd A. Alaback as a sales representative in the Tulsa area. He heads the Thermal Engineering Co., Tulsa. Alaback will promote the sale of jacket water coolers, evaporative coolers, and HC air-cooled coolers and condensers.

Schatz named assistant general manager

Raymond C. Shatz was named assistant general manager of the Cox Engineering Co., Inc., distributors, engineers, and contractors of fluid power equipment in Detroit and Toledo, Ohio. Prior to

Continued on next page

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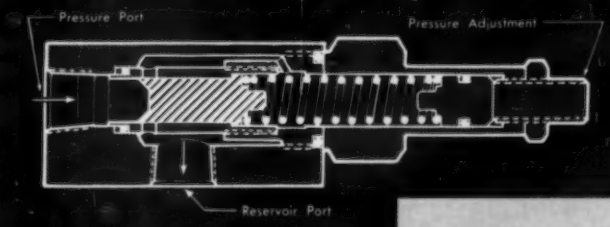
For Dependable Continuous Operation



Guided Piston RELIEF VALVE

- Long Life — hardened parts
- Accurate Low Pressure Regulation
- Compact
- Quiet
- Fast Response

- Adjust Ranges: up to 600 psi
- For Oil
- Flows: to 20 gpm
- Pipe Sizes: ¼", ⅜", ½", ¾" and 1" NPTF

Write for detailed literature.

Fluid Controls, inc.

Member of National Fluid Power Association

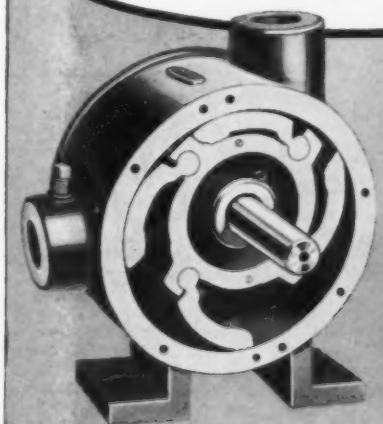
Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

P.O. BOX 186 • MENTOR, OHIO

Here's why LEIMAN AIR PUMPS

Put "Lifetime" Dependability into your Machines!



HINGED, CURVED VANES OF DURABLE CAST IRON

Take up their own wear

Four curved vanes on easy-action hinges scoop up large volumes of air and maintain perfect cylinder wall contact by centrifugal force. Vanes and cylinders are made of durable cast iron (no composition). They hone themselves to hard, glassy smoothness, reducing frictional wear to a minimum. Negligible wear is automatically taken up by rotating vanes. 2 to 3 times more air space is provided.

Typical reports from users:

"Never wear out or give trouble"

"Used 350 pumps without a complaint"

"Pumping 24 hours a day for 21 years"

"12 years without any attention, except lubrication"

•

If the operation of your machines depends on a reliable, steady source of vacuum (suction) or air pressure—install Leiman Air Pumps. They will last for the life of your equipment—providing fully-rated capacity, year after year, with little or no maintenance.

The simplified design of Leiman Air Pumps has fewer moving parts—provides greater capacity in smaller pumps to compact your designs. Airflow is smooth—operation extremely quiet. A wide range of models and sizes is available to meet your operating conditions. Experienced engineers are at your service on any design or installation problem.

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151 Christie St., Newark 5, N. J.
Established 1887

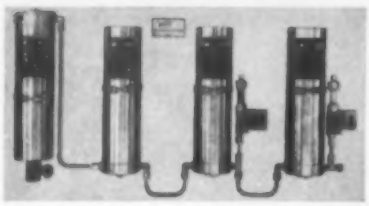
SEE OUR CATALOG IN SWEET'S FILE

Write for new catalog showing construction, types, sizes and specifications, plus Application Book containing many "how-to-do-it" blueprints.

LEIMAN Rotary Positive AIR PUMPS

Vacuum to 29.9" Hg. Pressure to 20 p.s.i.g. Volume to 162 c.f.m.

When water or oil in gases cannot be tolerated . . .



INSTALL ROBBINS

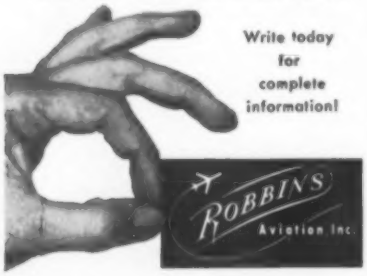
dehydration equipment

Robbins Aviation offers you both disposable cartridge type and refrigeration type dehydration systems for practically all types of gases . . . equipment designed and built to rigid quality control standards to give you maximum satisfaction in efficient trouble-free performance.

Robbins equipment is used extensively for aircraft pneumatic systems, test laboratory equipment, mobile compressor trailers, hydraulic system purging, missile charging and pressurizing systems, for instrument, laboratory, and factory air, controlled atmospheres for brazing and heat-treating furnaces, etc. Mechanical filters, drier and purifier chambers, refillable and disposable cartridges, dewpoint indicators also available.

Fast, positive, economical removal of water or oil vapor and impurities

Pressures to . . . . . 12,000 PSI
Safety Factor . . . . . 4 to 1
Dewpoints to . . . . . −100°F
Oil Vapor
Removed to . . . as low as 0.3 ppm/w



Write today for complete information!

Manufacturers of high quality valves and dehydration equipment

2350 E. 38th St., Los Angeles 58, Calif.
Ludlow 9-5221

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POST SCRIPTS OF INDUSTRY

joining the Cox organization, Schatz was associated with Detroit Aluminum & Brass, Packard Motor Co., and Briggs Mfg. Co.

Schatz

Piehl

Piehl to manage sales of Alemite marketing div.

M. W. Piehl has been appointed sales manager of the marketing div., Alemite Div., Stewart-Warner Corp., Chicago. He was head of Alemite lubrication and automotive service equipment sales to major oil and automotive jobbers. He joined Alemite in 1937.

Burkhardt promoted

Kenneth W. Burkhardt was appointed director, design standardization for American-Standard Industrial Division. Burkhardt joined the division's engineering analysis department in 1936, and held various positions in engineering till 1959 when he became product development engineer. Succeeding Burkhardt in that capacity is William E. Wendover.

New distributors

Greer Hydraulics, Inc., Los Angeles and New York, has named two distributors of its accumulators. *Hydraulic & Air Equipment Co., Inc.*, Portland, Oregon, will cover Washington, Oregon, and nine northern counties of California. *Paul-Munroe Hydraulics*, Bell Gardens, Calif., will take Arizona and the ten most southern counties of California.

Air Draulics Sales Co., Memphis, will represent Ortman-Miller Machine Co., Inc., in western Tennessee, Arkansas, Mississippi, and Louisiana.

Continued on page 160

Specify HALE ACCUMULATORS

- Piston Type
- 1 Pint to 23 Gallons
- 3000 PSI Working Pressure
- Low Piston Inertia
- Low Hysterisis
- 12,000 PSI Minimum Burst
- PROMPT DELIVERY . . . Most sizes from STOCK.

WRITE for our NEW 23-Page CATALOG

- No Obligation

FLUID POWER DIVISION

HALE FIRE PUMP COMPANY
Conshohocken, Pennsylvania

An Organization with over 45 Years of Hydraulic Experience

Circle **69** on Time-Saver Card

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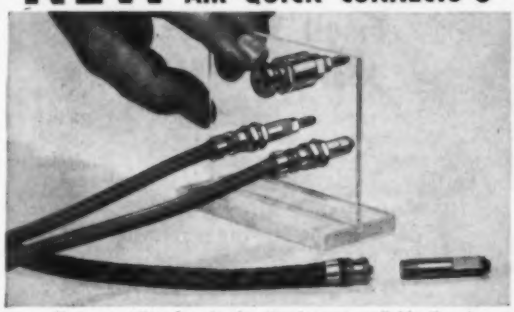
try it...at our expense

7 ways better than other thread-sealants you've used

Fast, easy, neat to apply... wrap once around joint, tear off, that's all! ■ Lubricates as it seals... no thread galling, even on stainless steel or plastic ■ Never hardens... maintains original seal forever... prevents frozen joints for easy disassembly *anytime* ■ Seals threaded, flared or butted joints ■ Unaffected by high temperatures, alkalies, acids, chemicals ■ Handy self-dispenser rolls ■ 1 to 2¢ per average joint.

Mail to: **FRIESLAND PLASTICS CO., Friesland, Wis.**
for free sample in ☐ ¼" ☐ ½" ☐ ¾" ☐ 1" width
Name..... Title.....
Company .....
Address .....
City..... State.....
AH F-10

NEW PANEL MOUNTING AIR QUICK CONNECTS!



● New versatility for air circuitry is now available thru two new styles of panel mounting CLIPPARD Quick-Connects.

Shown at middle left is MQC-3 with female 10-32 port at rear for metal or flexible tube fittings. At middle right is MQC-2, provided with male 10-32 thread. At bottom right is MQC-1 for clamp or manifold mounting. At top is the "Miniature Switch of Pneumatics" — CLIPPARD Miniature Air Valve MAV-3 equipped with push button, available in 2, 3 and 4 way models.

For complete data on these and other compact CLIPPARD Flow Control, Needle and Check Valves, Valve Solenoids, Fittings and Accessories —

Clippard Minimatics

Write for New Bulletin No. 960

Clippard INSTRUMENT LABORATORY, INC.

7386 Colerain Rd., Cincinnati 39, O. • Phone JAckson 1-4261

Manufacturers of Miniature Pneumatic Devices, R.F. Coils, Electronic Equipment

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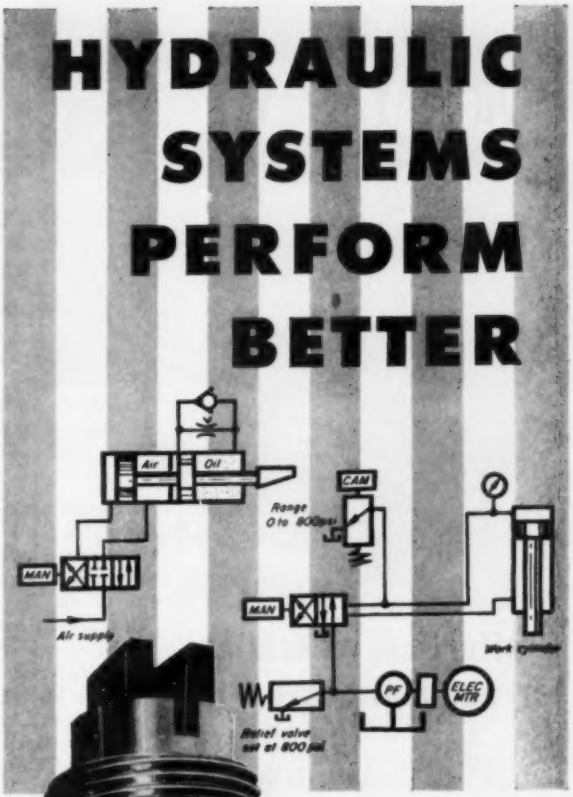
HYDRAULIC SYSTEMS PERFORM BETTER



with LISLE *Magnetic* PLUGS

Fouled valves and excessive pump wear are frequently caused by abrasive ferrous metal particles that are circulating in the fluid of a hydraulic system.

You can eliminate this problem by installing a Lisle Magnetic Plug in the flow path or sump. The powerful magnet in the Lisle Plug attracts and holds these ferrous particles; assures better performance of the entire hydraulic system.

LISLE CORPORATION
CLARINDA • IOWA

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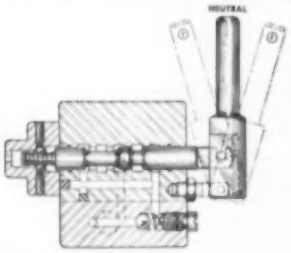
new 10,000 psi FOUR-WAY VALVES

effortless operation for applications up to 10,000 psi

Have valving problems on hydraulic applications calling for high pressures up to 10,000 psi? This new GREENLEE Four-Way Valve may be your answer. Simple, trouble-free spool-type valve . . . completely balanced to provide effortless operation at any pressure in any position. It operates with the same ease at 10,000 psi as at 0 psi. Panel mounted for universal adaptability. Subplate available. Precision-made, precision-tested. (Max. leakage 4 cu. in. per minute at 10,000 psi.) Write today for illustrated data sheet.



GREENLEE Four-Way Valve is available in two models: No. 1717 (above) with detent-positioned control lever . . . No. 1704 with spring-centered control lever.

THE GREENLEE LINE ALSO INCLUDES A WIDE SELECTION OF HAND AND POWER-OPERATED HYDRAULIC PUMPS

GREENLEE

GREENLEE TOOL CO.
1776 Columbia Ave., Rockford, Illinois

Circle **66** on Time-Saver Card

POST SCRIPTS OF INDUSTRY

Sheffer Corp., Cincinnati, has named four distributors. *Air & Hydraulic Equipment Co.*, Hackensack, N. J. serves New Jersey. Covering Nebraska and western Iowa is *Brand Hydraulics*, Omaha. *Carbide Service Co.*, Detroit, has the Michigan territory. *Tri-State Supply Co. of New York*, Brooklyn, is assigned to the five boroughs of New York and Long Island.

Hannifin Co. Div., Parker-Hannifin Corp., Des Plaines, Illinois, has named two firms to distribute its air and hydraulic cylinders and air valves. They are *Louis H. Hein Co.*, West Conshohocken, Pa., Jersey City, and Baltimore; and *Nielsen Hydraulic Equipment, Inc.*, Pelham Manor, N. Y. Nielsen has branches in Linden, N. J., and West Hartford, Conn. *Manufacturer Supply Co.*, Chicago, and *Ritter Engineering Co.*, Milwaukee, will handle Hannifin's Crown line of compressed-air preparation units. *Supplies for Industry, Inc.*, Tucson, will distribute hose and reusable fittings made by Parker Fittings & Hose Div., Cleveland and Eaton, Ohio. *Depatie Fluid Power Co., Inc.*, Kalamazoo, is franchised for the division's tube fittings and tube working tools. Newly-formed *Fluidline Engineering, Inc.*, Chicago, has taken over Wallace Tube Div.'s distributorship on Parker tube and hose fittings, and the accumulators of Parker Hydraulics Div., Cleveland. Fluidline is franchised for Hannifin air valves, cylinders, and compressed-air preparation units. Wallace Tube will devote full attention to its pipe and tube fabricating equipment and services.

Industrial nylon hose of Synflex Products Div., Samuel Moore & Co., Mantua, Ohio, will be handled by *Hope Rubber Co.*, Fitchburg, Mass., *F. B. Wright Co.*, Dearborn, *Shively Brothers, Inc.*, Flint, and *Kent Rubber Supply Co.*, Grand Rapids. *Continental Air Equipment*, Brooklyn, will specialize in Synflex self-storing air hose.

Continued on page 162

New...from MARSH!

Conduit-type Master-mite. Grommet-type also available.

Small Solenoid Valves that fill a BIG Order

Designed to meet the need for positive-acting tight-seating valves for use on wide variety of media, including oxygen, hydrogen, acetylene, etc.

Two Types:
Conduit type and grommet type. Port sizes 1/8" and 1/4" NPT.

Ten orifice sizes: 3/64" through 1/4".

Wide range of voltages:
Standard with 115 V. A. C. but also available in 12, 24, 208, 230, 460 V. A. C.

Pressure to 540 psi.
Small, but with more strength in the Marsh manner. Coils never overheat. Entire assembly leak tight. Remarkably quiet operation. Cleanable without breaking connections. Used in any position. Bodies either brass bar stock or 18-8 stainless steel. All moving parts stainless. Underwriters' approved for use on oxygen and hydrogen and as safety valves.

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Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada, Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.

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HANDS OFF!

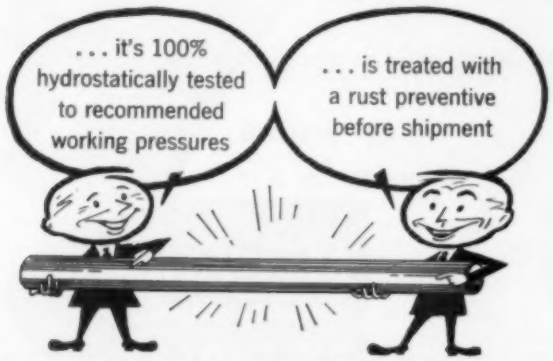
Mark 6 Model

No hands needed to maintain exact required pressure indefinitely! Now save the time and effort of a hand pump. Ideal for valve and fitting testing and as hydraulic power source for operating small presses, jacks, rams, clamping devices, etc. Choice of 6 models for pressures to 10,000 PSI (working from compressed air at 5 to 100 PSI). Also Single and Double-Acting AIRHYDROPUMPS with pressures to 100,000 PSI. Write for complete information.

AIRHYDROPUMP JUNIOR

DAVIES BROS. GLADSTONE, NEW JERSEY

TubeXperience in action



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- **Complete range of sizes** stocked and sold by leading steel "Service Centers."

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The big name in small tubing

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All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

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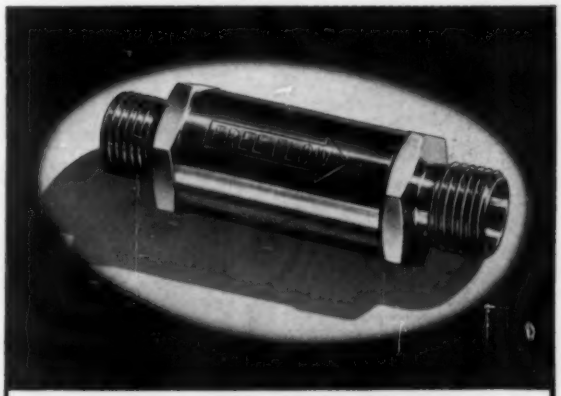

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Kohler Precision Controls include a wide range of valves, fittings and parts in various types and sizes for industrial equipment, automotive, aircraft and missile applications. Complete facilities in one plant, with unified supervision, contribute to maximum control in manufacture, prompt deliveries. Ultra-sonic cleaning facilities. Air filtered to 10 microns in area where hydraulic system components are assembled, tested and packaged. Write for information.

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PRESSURE RELIEF VALVES

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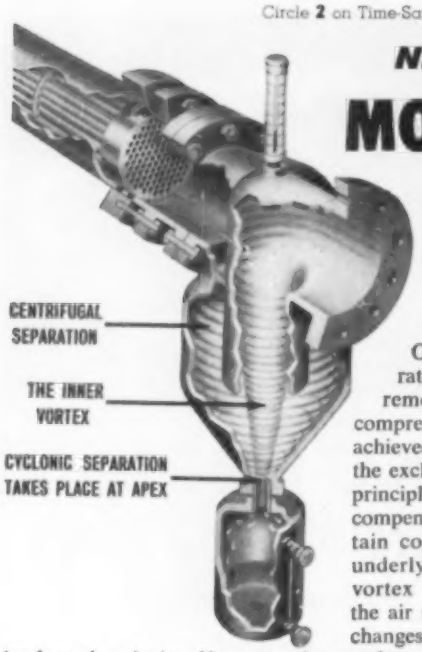

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MOISTURE AND OIL REMOVAL?

(for your compressed air system)

Only the Adams CYCLONE Separator assures peak efficiency in the removal of oil and water from your compressed air system. Top operation is achieved from one-quarter to full load by the exclusive cyclone design. It is a proven principle of operation which automatically compensates for variation in load to maintain constant separating efficiency. The underlying feature is the inner cyclonic vortex formed within the unit itself by the air stream. The diameter of the vortex changes in proportion to variations in the load or air velocity. However, the angular air velocity, the RPMs, remain constant — and it is the angular velocity — the infinite changes of direction, which effect the separation of entrained particles at practically constant efficiency.

Remember, your aftercooler is only as effective as the separator which removes the condensed oil and water. Find out today how the Adams design can improve your oil and moisture removal efficiency. Write today for your copy of Bulletin 714.

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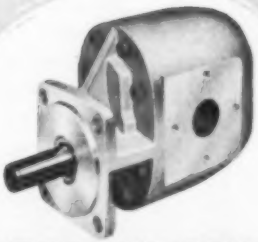
Speeds to **2800 RPM**

Temperatures to **250° F** with min. **55 SSU**

Pressures to **2250 PSI** continuous

Flow rates to **60 GPM**



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- Designed for operation at mobile equipment engine speeds
- Can be direct-connected, gear driven or belt driven
- Conforms to SAE standards

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Corinth 1, Miss.

Name_____

Company_____

Berry HYDRAULICS
A DIVISION OF THE OLIVER TYRONE CORPORATION

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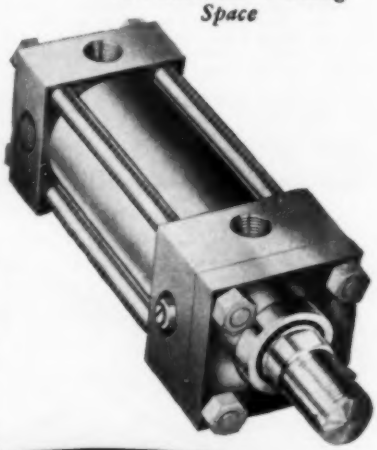
POST SCRIPTS OF INDUSTRY

Automation Equipment & Supply Co., Pittsburgh, is now a sales representative of Fluid Controls, Inc., Mentor, Ohio. The company will sell the hydraulic valves and devices in western Pennsylvania, West Virginia, and eastern Ohio.

Industrial Air Equipment Co., Indianapolis, will market the air filters, regulators, and lubricators of Wilkerson Corp., Englewood, Colorado. Industrial will cover Indiana.

Maximum Working Force in Minimum Working Space



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- **Quality Construction Throughout**
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- **Conforms to JIC Specifications**

Get all the facts and see how Milwaukee Cylinders save space and weight . . . Save on original cost and save on maintenance.

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Specials built to your specifications

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Manufacturers Agent covering OEM Industrial, Aircraft, Automotive interested in new lines, Michigan, Indiana, Ohio. Write Box 10260, HYDRAULICS & PNEUMATICS.

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SENIOR SALES ENGINEER WANTED

Broad experience in sales of major hydraulic components to steel and equipment industries. Must be able to represent Company at top engineering and purchasing levels. Positions open in the Cleveland and Pittsburgh area. Some travel required. Age 35 to 50. Salary $10,000 plus. A fine growth opportunity. All replies confidential and will be acknowledged. Write Box 10360, HYDRAULICS & PNEUMATICS.

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Has bore of 3" – shaft 1-3/16" – stroke 24" – O/A length 31". Reconditioned.
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TO ORDER: Send Check or M.O. – 1/2 deposit with C.O.D.s. Prices F.O.B. Los Angeles. All items shipped freight or postage collect.

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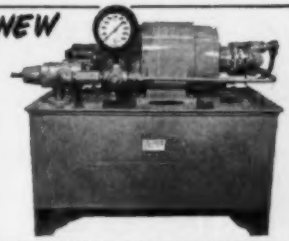

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PUMPING UNITS
DELIVERS 21 GPM AT 1500 PSI

For use in applications where a fast approach to work load is desired. Will deliver combined volume of both pumps (21 GPM), at pressures up to 450 PSI, then delivers output of high pressure pump (4 GPM) at up to 2000 PSI. Both pumps are face mounted on a 5HP, double end, 220/440, 3-phase, 60 cycle AC motor. Mounted on a 33 gal. reservoir (available without reservoir) Size: 35" long x 18½" wide x 18½" high. Other Hi-Lo units available, write for details. Cat. No. DPR-21-1500.. Only 625.00

2250 PSI CORNELIUS COMPRESSOR AND 115 V. MOTOR
SAVE! 99.50
OUTPUT 0.6 CFM

Consists of a Surplus Cornelius Compressor – combined with a New 1/2 HP, 115/230 V., 60 cycle AC motor; a mounting frame and built-in carrying handle. Pressure tested up to 3000 PSI. Ideal to fill air tanks, laboratory use, etc.

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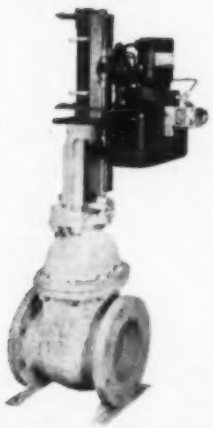


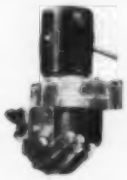
for any type or size of valve!

NOW—a complete valve actuator so small it requires less room than a conventional hand wheel . . . so powerful it provides smooth, positive action on any valve.

The Oil-Dyne valve actuator provides two separate pressures, a higher opening pressure and a lower closing pressure, to protect valve components. Any combination of pressures from 50 to a peak of 5000 psi can be arranged.

For indoor or outdoor service, direct or remote control, Oil-Dyne valve actuators can be equipped with any type of safety device and signal, explosion-proof features, and a hand pump for emergency manual control.

Oil-Dyne will install actuators on any valve furnished by the customer directly or through any valve manufacturer, or will furnish complete actuators, including mounting devices, to customers wishing to make their own installation. For complete information, write for Catalog VA-10.



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PRESSURE SWITCHES • ACCESSORIES

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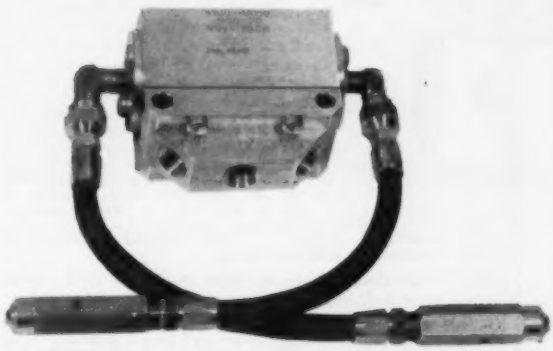
with NOVI's proven air-saver valve

combining DIRECT AIR, NOVI-MATIC 4-WAY VALVES and NOVI POPPET VALVES



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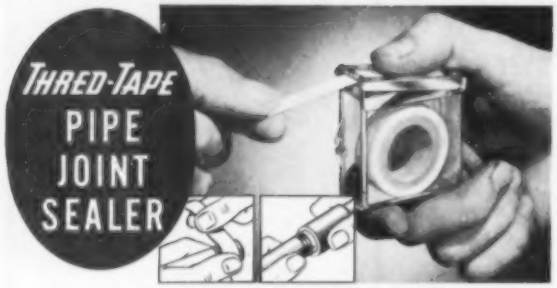

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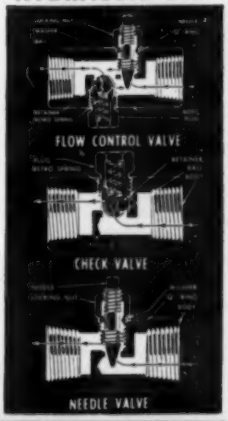
Circle **171** on Time-Saver Card

Get Easier, More Accurate Cylinder Speed Control

2,000 (brass or aluminum) and 5,000 (steel) p.s.i.

with **Pneu-Trol®** VALVES IN AIR OR HYDRAULIC USE



Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in 5 female pipe sizes — ⅛" to ¾". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

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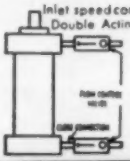

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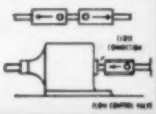

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Compact axial-piston air motor cuts limited-space problems

Gardner-Denver axial-piston design packs 2.7 hp in 6 3/16" dia. x 13 3/4", weighs 38 lb.—permitting use in places where space is limited. Rigid spindle, heavy-duty bearings and rugged case give this air motor the ability to carry an overhung load as great as 1000 lb. with no external spindle support. Speeds to 2600 rpm. Starting torque to 82 ft.-lb. Variable speed. Reversible. Nonsparking. Works in heat, moisture or dust. Can be mounted at any angle. Other sizes from 0.6 to 2.7 hp.

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In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

GARDNER-DENVER

Circle **60** on Time-Saver Card

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October 1960

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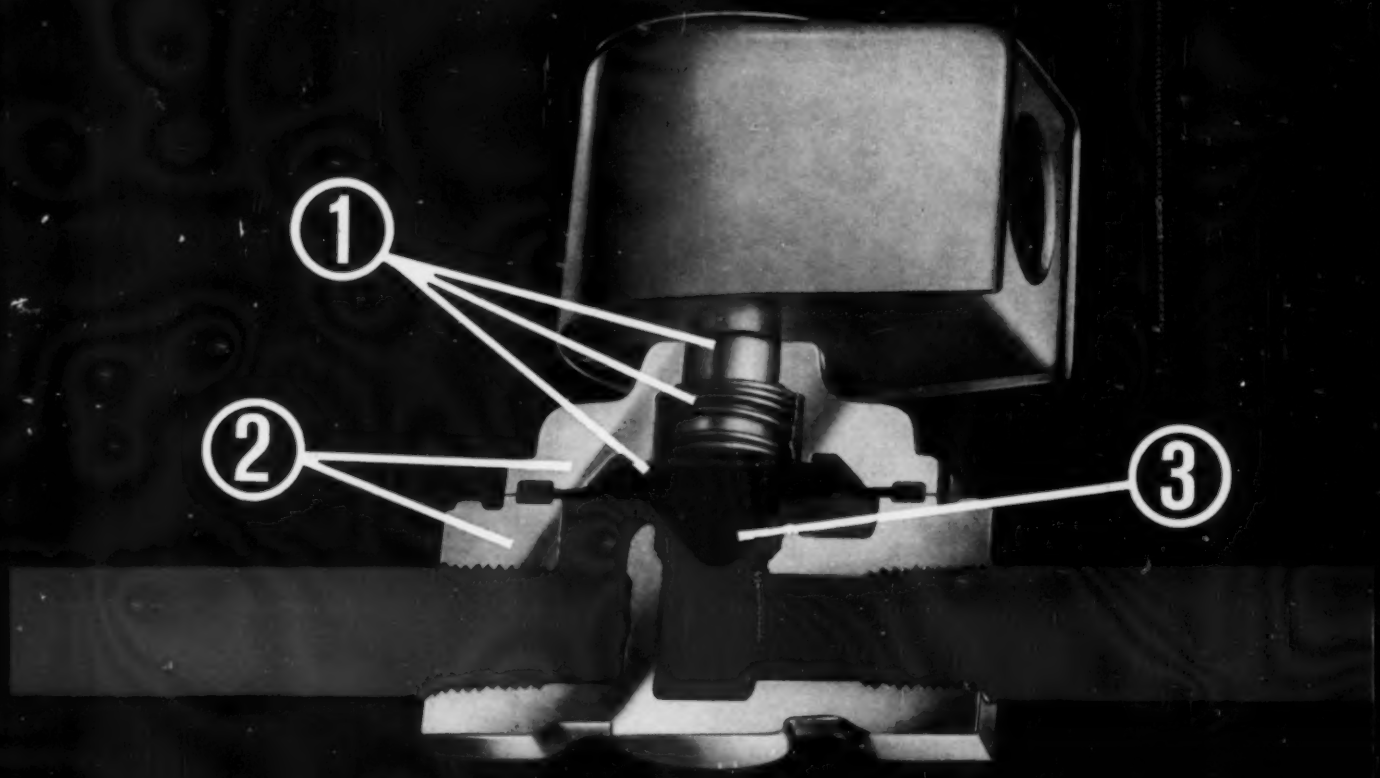
TIME SAVER CARD ---------- HYDRAULICS & PNEUMATICS

SIMPLICITY, RUGGEDNESS, TIGHT SEATING,



WITH ASCO'S COMPLETE LINE OF 2-WAY SOLENOID VALVES

ASCO general purpose packless valves are now provided in a full ⅜" to 3" range . . . handle pressures up to 350 p.s.i. . . . ½" and ¾" sizes available to 1500 p.s.i. . . . provide dependable flow control for air, gas, water, light oil and other non-corrosive fluids.

Check these features of the Bulletin 8210A:

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2. **Ruggedness:** Forged brass bonnet and body insure freedom from porosity.
3. **Tight shut-off:** Assured by resilient disc construction.

Compactness: 2¾" face to face; 3¼" pipe center line to top of solenoid; 3-13/16" overall height. (Normally closed, ⅜" x ½" sizes.)

Mountable in any position: Normally open or normally closed.

Fast action: Rapid filling-venting operation permits cycling rate to 400 per minute.

All sizes have full area ports, continuous duty coils designed for low temperature rise and long life, and are available normally open or normally closed with standard, water tight or explosion proof solenoid.

Whatever the crucial factor in your flow-control application – reliability, compactness, high cycling rate – there is an ASCO valve that meets your need.

For Immediate Delivery . . .

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New! Catalog No. 202 covers the ASCO line of Solenoid Valves. Write for your copy today.

ASCO Valves

Automatic Switch Co. 50-8 HANOVER RD., FLORHAM PARK, N. J., FRONTIER 7-4600

AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

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FOR CUSTOM COMPOUNDED PRECISION FABRICATED

Go Goshen RUBBER

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TO MEET ADVANCED REQUIREMENTS

Capitalize on Goshen's experience in serving the needs of hundreds of large and small users of o-rings in the United States and Canada. Precise control of quality thru every stage of formulation and manufacture is the key to an outstanding record of sealing success.

GRC o-rings in all standard AN, MS, SAE and JIC sizes, in many non-standard sizes and in special sizes, are available from established and proven synthetic and silicone specification compounds. Go Goshen for efficient sealing under most any given conditions.

Ask for your free copy of 16-page O-ring Brochure on size, groove dimensions, compounds and other helpful information.

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IF YOU BUY OR SPECIFY O-RINGS

YOU NEED THIS BROCHURE ON

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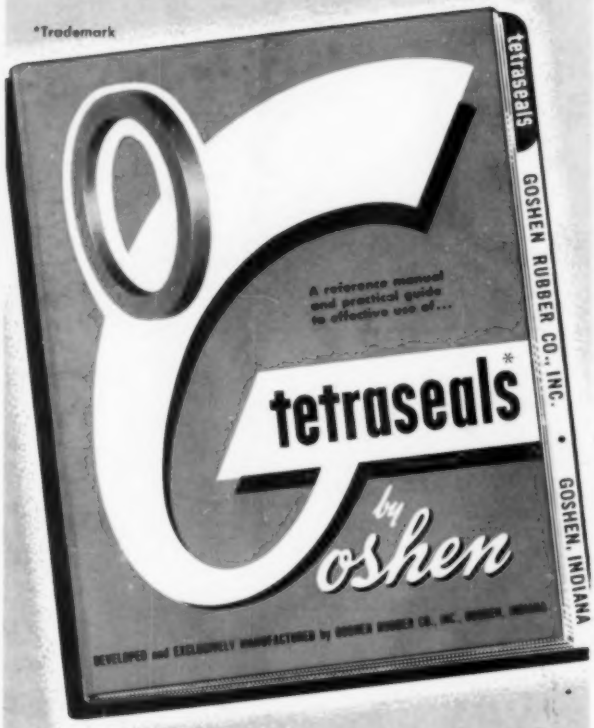
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